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MYCOTAXON

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NEW PARMELIACEAE (LICHENES) FROM THE GUIANAS AND SURROUNDINGS

by

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summary

Five new species in the family Parmeliaceae (Lecanorales, lichenized Ascomycetes) are described, which have been discovered among recent collections from the three Guianas, Venezuela and Colombia (tropical South America): *Bulbothrix leprieurii* Aubel, *Parmotrema aptrootii* Aubel, *P. aurantiacoparvum* Sipman, *P. gradsteinii* Aubel and *P. verrucisetosum* Sipman.

Introduction

During the preparation of a treatment of Parmeliaceae for the Flora of the Guianas, five new taxa were discovered, for which descriptions are presented below.

Chemistry was analyzed by thin layer chromatography on Merck 60F-254 precoated plates with the solvent systems A & B according to White & James (1985).

The directors and curators of the herbaria from which collections were obtained on loan, are gratefully acknowledged, especially Dr. R. C. Harris (NY) for selecting specimens of special interest. Likewise dr. A. Fletcher (Leicester, U.K.) and dr. E. Sérusiaux (Liege, Belgium) for checking the manuscript and valuable advice. Much appreciated is the

support of the organizations FUDECI (Venezuela) and Corporacion de Araracuara (Colombia), who provided opportunities to collect material.

1. *Bulbothrix leprieurii* Aubel, sp. nov. Fig. 1.

TYPE: Guyana, Upper Mazaruni district, small white sand-savannah c. 2 km S of Waramadan, epiphyte on isolated, dwarfed tree, alt. c. 600 m, coord. 5°47' N, 60°46' W, 1 March 1985, H. Sipman & A. Aptroot 19187 (U holotype).

DIAGNOSIS: Thallus planus, arcte applicatus, pallide cinereus, usque ad c. 3 cm diametro, lobis sublinearibus - elongatis, c. 0.5 mm latis, bulbato-ciliatis, bulbis atris apice furcato-ciliatis, superne planis, soraliis superficialibus ad 0.6 mm diametro, sorediis c. 50 µm diametro, inferne atris, ad apices fuscis, rhizinis instructis; rhizinis sparsis, basi inflatis, atris, furcato-ramosis, ad 0.2 mm longis. Apothecia et pycnidia ignota. Materiae chimicae (TLC): atranorinum, acida gyrophoricum et lecanorinicum.

DESCRIPTION: Thallus corticolous, closely appressed, flat, light grey, up to over 3 cm wide; lobes sublinear - elongate, c. 0.5 mm wide; cilia black, bulbate with repeatedly dichotomously branched tips, to 0.2 mm long; upper surface mostly flat, continuous or in central parts ± transversely cracked, sorediate; soralia superficial, pale grey, rounded, c. 0.6 mm wide, flat, at last often excavate and showing the black lower cortex, producing c. 50 µm diam. soredia; lower surface black, near the lobe tips brown, sparsely rhizinate; rhizines slightly inflated at base, strongly dichotomously branched, black, to c. 0.2 mm long. Apothecia and pycnidia unknown. Chemistry (TLC): atranorin and gyrophoric acid with variable amounts of orsellinic and lecanoric acids. Colour reactions: medulla K-, C+ rose, KC+ rose, P-, UV-; surface K+ yellow, UV-.

DISTRIBUTION: Known thus far from Guyana and the Amazonian part of Colombia. Available collections are from light and low virgin forest with a humid tropical climate, or in disturbed places in such forest, at c. 200 and 600 m elevation.

ADDITIONAL SPECIMENS: COLOMBIA, Comisaría AMAZONAS, comunidad de Villazul, E of Araracuara, N-bank of river Caquetá, opposite Isla Mariñame, "Pantano de Monica Sosa", alt. c. 240 m, coord. 0°42' S, 72°07'W. c. 6 m tall, light forest, dominated by small *Clusia* and Bombacaceae, on peat, 4 km N of the river, 2 Nov. 1988, H. Sipman & J. Duivenvoorden 28392 (B). GUYANA, Upper Mazaruni district, Jawalla village, at confluence of Kukui river and Mazaruni river, in cultivated, wel-lit area near the village, coord. 5°40'N, 60°29'W, alt. c. 500 m, 6 Febr. 1985, H. Sipman & A. Aptroot 18372a (B).

NOTES: The name of the new species is chosen in honour of F. R. Leprieur, famous collector of cryptogams in Guyane française.

B. leprieurii is the second sorediate species known in the genus. It differs from the other sorediate species, *B. imshaugii* (Hale) Hale, by the presence of gyrophoric acid instead of salazinic acid, and by its narrower, emaculate lobes (Hale 1976: 16). *Bulbothrix oliveirai* Fletcher appears to agree in chemistry, colour of lower side, shape of rhizines and cilia, but differs by being pustulate and rarely producing a few coarse soredia (Hale 1986: 86). Moreover the new species is not densely rhizinate on its lower side.

The occurrence of orsellinic and lecanoric acids besides gyrophoric acid is probably an artifact due to hydrolysis of gyrophoric acid in acetone solution, according to Leuckert (pers. comm.). Gyrophoric acid should be considered as the diagnostic substance.

In the Guianan specimens the soralia are always flat to excavate, in the Colombian plant they are partly capitate and partly flat to excavate.

2. *Parmotrema aptrootii* Aubel, sp. nov. Fig. 2.

TYPE: Guyana, Upper Mazaruni district, Kamarang, in the village, on Mahogany tree on river-bank, coord. 5°52' N, 60°37' W, alt. c. 500 m, 3-26 Febr. 1985, H. Sipman & A. Aptroot 18187 (U holotype).

DIAGNOSIS: Thallus adnatus, pallide viridis vel viridocinereus, c. 10 cm diametro; lobi apicibus rotundatis, 3-6 mm latis, eciliati, marginibus crenulato-undulatis, sorediosis; soralia ad partibus elevatis marginum, punctiformes vel elongata, sorediis agglutinatis; latus superior emaculatum, planum, ad margines cortice fragile; medulla alba; latus inferior ad apices fuscum et nudum, in centro ater et rhizinis instructum in partibus ad substratum appressis; rhizinae parvae, nigrae, ad 0.4 mm longae, simplices. Apothecia et pycnidia ignota. Materiae chimicae (TLC): acida usnica, echinocarpica et protocetrarica.

DESCRIPTION: Thallus corticolous, adnate, pale yellowish- to greenish grey, c. 10 cm diam.; lobes with rotund, 3-6 mm wide tips and crenulate-undulate, sorediate margins; soralia on raised parts of the margin, punctiform or expanding along the margin, soredia long remaining agglutinated in coralloid masses; cilia lacking; upper surface dull, emaculate, smooth and continuous near the tips, rugulose and cracked in the central parts, with flaking cortex near the raised lobe margins; medulla white, without pigment; lower surface black, near the lobe tips brown, rugulose, slightly glossy, naked in a c. 3 mm wide zone at the lobe tips, with patches of dense, small rhizines on appressed parts in the centre of the lobes; rhizines slender, usually up to 0.4 mm long and unbranched, black. Apothecia and pycnidia unknown. Chemistry (TLC): usnic, echinocarpic and protocetraric acids. Colour reactions: medulla K+ yellow, C+ orange (short and fading), KC+ rose, P+ orange, UV-; cortex K-, UV-.

DISTRIBUTION: Known only from Guyana and, with some doubt, from Colombia.
The specimens are from well-lit sites with a humid tropical climate at 200 and 500 m elevation, i.c. on a Mahogany tree in a village and in stunted forest on peat.

ADDITIONAL SPECIMENS: COLOMBIA, Comisaría AMAZONAS, comunidad de Villazul, E of Araracuara, N-bank of river Caquetá, opposite Isla Mariñame, "Pantano de Monica Sosa", alt. c. 240 m, coord. 0°42' S, 72°07'W. c. 6 m tall, light forest, dominated by small *Clusia* and Bombacaceae, on peat, 4 km N of the river, 2 Nov. 1988, H. Sipman & J. Duivenvoorden 28394 (B)

NOTES: The name is chosen in honour of A. Aptroot, a Dutch lichenologist who made important lichen collections in tropical countries.

P. aptrootii is well characterized by its chemistry, which comprises usnic acid as only cortical substance and echinocarpic and protocetraric acids as medullary components. A somewhat similar species with echinocarpic and protocetraric acids in the medulla is *P. dilatatum*. It differs by its non-coralloid soralia and by having atranorin as main cortical substance. Another similar species, *P. apricum* (Krog & Swinscow) Krog & Swinscow, lacks echinocarpic acid and has equally non-coralloid soralia (Krog & Swinscow 1981: 170).

The Colombian specimen is slightly aberrant by the absence of well-developed soralia and by a less glossy, more rugulose lower side. It is tentatively referred to *P. aptrootii*.

3. ***Parmotrema aurantiacoparvum*** Sipman, sp. nov. Fig. 3.

TYPE: Guyana, Upper Mazaruni district, small white-sand savannah c. 2 km S of Waramadan, alt. c. 600 m, coord: 60°46' W, 5°47' N, 1 March 1985, H. Sipman & A. Aptroot 19186 (B holotype).

DIAGNOSIS: Thallus adnatus, pallide cinereus, ad c. 4 cm diametro; lobi apicibus rotundatis 3-4 mm latis, marginibus crenulato-undulatis, isidiati; isidia coralloidea, fragilia, ad 0.3 mm longa, marginalia vel submarginalia, nonnumquam ciliata; cilia numerosa, nigra, ad 3 mm longa, tenues; latus superior emaculatum, planum vel in centro rugulosum, cortice ad marginibus loborum fragile; medulla aurantiaca; latus inferior ad apices fuscum nudum, in centro ater, rhizinis instructum in partibus ad substratum appressis; rhizinae nigrae, ad 0.5 mm longae, vulgo simplices. Apothecia et pycnidia ignota. Materiae chimicae (TLC): atranorinum, pigmenta ignota.

DESCRIPTION: Thallus corticolous, adnate, pale grey, sometimes slightly brownish, 2-4 cm wide; lobes with crenulate, 3-4 mm wide tips and crenulate-undulate, isidiate margins with flaking cortex; isidia coralloid-branched, concolorous with the thallus but brown-tipped, marginal or submarginal, up to c. 0.3 mm long, fragile, when well developed sometimes ciliate; cilia usually abundant, (1-)2-3 mm long, black, slender; upper surface dull, emaculate, smooth and continuous near the tips, rugulose and irregularly cracked in the central parts; medulla pigmented throughout, rusty orange, more intensely coloured near the lobe tips; lower surface black, near the lobe tips brown, more or less rugulose, slightly glossy, naked in a c. 3 mm wide zone at the lobe tips, sparsely rhizinate in the central part of the thallus, at least on appressed parts; rhizines 0.5 mm long and mostly unbranched, black. Apothecia and pycnidia unknown. Chemistry (TLC): atranorin and several unknown pigments or other substances. Colour reactions: medulla K+ dark purple (pigment!), C+ weakly purple, P-, UV-; cortex K+ yellow, UV-.

DISTRIBUTION: Thus far known from Colombia, Venezuela, Guyana and Guyane Française, where it has been collected on canopy branches or on small trees in well-lit forest or clearings.

ADDITIONAL SPECIMENS: COLOMBIA: Comisaría AMAZONAS, Comunidad de Villazul, E of Araracuara, Isla Mariñame in river Caquetá, alt. 240 m, coord. 0°45' S, 72°06'W, swamp with *Mauritia flexuosa* and little trees, c. 1.5 km S of the river, 1 Nov. 1988, H. Sipman & J. Duivenvoorden 28175 (B); Comisaría AMAZONAS. Comunidad de Villazul, E of Araracuara, N-bank of river Caquetá, opposite Isla Mariñame, "Pantano de Monica Sosa", alt. c. 240 m, coord. 0°42' S, 72°07'W, c. 6 m tall, light forest, dominated by small *Clusia* and Bombacaceae, on peat, 4 km N of the river, 2 Nov. 1988, H. Sipman & J. Duivenvoorden 28435 (B). GUYANE FRANÇAISE: Saül, primary forest near Boeuf Mort, alt. 200-300 m, coord. 53°12'W, 3°38'N, on branches 25 m high [in canopy], March 1985, A. Aptroot 15295 (U). GUYANA: Upper Mazaruni district, Kamarang, in the village, epiphyte on *Citrus*, coord. 60°37'W, 5°52'N, alt. c. 500 m, 3-26 Febr. 1985, H. Sipman & A. Aptroot 18125b (U); Upper Mazaruni district, Pakaraima mountains, c. 2 km NW of Kamarang, on thin stemlet in c. 10 m tall, well-lit savannah-forest on ridge, coord. 60°38'W, 5°53'N, alt. c. 500 m, 4 Febr. 1985, H. Sipman & A. Aptroot 18284 (U); Upper Mazaruni district, N-slope of mount Roraima, c. 25 m tall, virgin, mossy forest, 25 m high in treecrown, coord. 60°46'W, 5°17'N, alt. 700 m, 12-19 Febr. 1985, H. Sipman & A. Aptroot 18819 (U); Upper Mazaruni district, trail from Kamarang river to Pwipwi mountain, in savannah bush c. 5 km N of Waramadan, coord. 60°46'W, 5°54'N, alt. c. 650 m, 27 Febr. - 1 March 1985, H. Sipman & A. Aptroot 19241a (B). VENEZUELA: Estado BOLIVAR, Cerro Guaiquinima, in central part of upper plateau (near camp 4), coord. c. 5°40'N, 63°34'W, alt. c. 950 m., low, mossy forest on rocky sandstone slope towards stream, 6 Febr. 1990, H. Sipman 26651a (B, VEN)

NOTES: The name reflects the conspicuous orange colour of the medulla and the small size of the plants.

P. aurantiacoparvum resembles most closely *P. mellissii* (Dodge) Hale, by its margins with long cilia, flaking cortex and fragile, ciliate isidia. However, soredia are never found in *P. aurantiacoparvum*, and the medullary chemistry is different. A similar rusty orange medulla seems unknown in any other *Parmotrema* species and is e.g. not mentioned by Hale (1974, 1990). The nature of the pigment is unknown; judging from the K-reaction, it might be an anthraquinone.

5. ***Parmotrema gradsteinii*** Aubel, sp. nov. Fig. 4.

TYPE: Guyane Française, Saül, fallen from canopy, 7 Aug. 1982, Boom & Mori 1521 (U holotype).

DIAGNOSIS: Thallus laxe adnatus, pallide cinereus, ad c. 10 cm diametro; lobi apicibus rotundatis 5-10 mm latis, marginibus undulatis; soralia, lobuli, pustuli isidiaque nulla; cilia numerosa, nigra, ad 2 mm longa, nonnumquam fasciculata; latus superior emaculatum, planum vel in centro rugulosum; medulla alba; latus inferior ad apices fuscum, nudum, in centro ater, rhizinis sparsis in partibus ad substratum appressis instructum; rhizinae nigrae, vulgo ad 1 mm longae, simplices. Apothecia concava, stipite angusto brevi, imperforata, margine crenulato, hymenio 80-150 µm alto, sporis 24-28 x 12-18 µm. Pycnidia conidiis ad 7 µm longis et 0.8 µm crassis, sublageniformibus. Materiae chimicae (TLC): atranorinum, acida gyrophoricum et lecanoricum.

DESCRIPTION: Thallus corticolous, loosely adnate, pale grey, available fragments up to 10 cm diam.; lobes with rotund or crenulate, 5-10 mm wide tips and slightly undulate, entire margins; lobules, isidia, pustules and soralia absent; cilia numerous, c. 1.5-2 mm long, black, often bundled, especially in the shallow sinuses of crenulate lobe tips; upper surface dull, emaculate, smooth and continuous near the tips, rugulose and slightly cracked in the central parts; medulla white, without pigment; lower surface black, near the lobe tips brown, smooth or rugulose, slightly glossy, naked in a wide (over 5 mm) zone at the lobe tips, with isolated rhizines or small patches of rhizines on appressed parts in the centre of the lobes; rhizines usually up to 1 mm long and unbranched, black. Apothecia densely crowded, concave, with short and narrow stalk, imperforate, 2-5 mm wide, with strongly crenulate margin and brown disc; outer wall smooth or slightly rugulose; hymenium 80-150 µm high; spores 24-28(-30) x 12-18 µm. Pycnidia with up to 7 µm long and 0.8 µm thick, sublageniform conidia. Chemistry (TLC): atranorin, gyrophoric and lecanoric acids. Colour reactions: medulla K-, C+ red, KC+ red, P-, UV-; cortex K+ yellow, UV-.

DISTRIBUTION: Only known from Guyane française and Surinam, from canopy branches in primary forest around Saül, from low forest in Haut-Marouini, and from the Wilhelmina Mountains, at 200-300 m. elevation.

ADDITIONAL SPECIMENS: GUYANE FRANÇAISE: Saül, primary forest near Boeuf Mort, alt. 200-300 m, coord. 53°12' W, 3°38' N, March 1985, A. Aptroot 15294 (U); Saül, 2 km SW of the village, "sentier limonade", alt. 180-210 m, coord. 03°32'N, 53°12'W, lowland moist forest on lateritic soil, epiphytic on outermost canopy branches of *Brosimum parinarioides*, 11 July 1986, D. Montfoort & R.C. Ek 1233 (U); Camp no. 4 - Roche no. 2 Monpé Soula - Bassin du Haut-Marouini, 5 km à l'Ouest, alt. 300 m, coord. 54°04'W, 02°39'N, savane roche, sur arbustes des fourrés sommitaux, epiphyte, 31 Aug. 1987, J.J. de Granville, L. Allorge, W.J. Hahn, M. Hoff & Weizman 9911 (U). SURINAM: Wilhelmina Mountains, frequent on *Cochlospermum*, in forested hills 9 km north of Lucie Rivier, 12 km west of Oost Rivier, alt. 275 m, 17 July 1963, B. Maguire, J. P. Schulz, T. R. Soderstrom, N. Holmgren 54235 (NY).

NOTES: The name is chosen in honour of S. R. Gradstein, Dutch bryologist and leader of the expedition to Mount Roraima in 1985, which brought the largest lichen collections available until now from the Guianas.

P. gradsteinii is well characterized by the presence of gyrophoric acid as medullary substance and by its crenulate apothecia. A somewhat similar species is *P. abnuens* (Nyl.) Hale, which has the same C+ red medullary reaction. However, in *P. abnuens* this is caused by the presence of olivetoric acid, and the thallus is maculate (Hale 1965: 277). Another fairly similar species is *P. hololobum* (Hale) Hale: it differs by its perforate apothecia with smaller spores [(12)15-18(20) x (6)8-10 µm] and filiform conidia up to 16 µm long (Krog & Swinscow 1981: 186).

The presence of lecanoric acid is probably an artifact, see remark under *Bulbothrix leprieurii.*

Pycnidia were found only in Boom & Mori 1521, mature apothecia in Boom & Mori 1521, Maguire et al. 54235 and Montfoort & Ek 1233.

Remarkable is the limited distribution of this species: it seems restricted to the eastern part of the Guianas and appears to be absent from the Guiana Highlands, the principal diversity centre of the region.

5. ***Parmotrema verrucisetosum*** Sipman, sp. nov. Fig. 5, 6.

TYPE: Guyana, Upper Mazaruni district, trail from Kamarang river to Pwipwi mountain, N of Waramadan, rocky savannah c. 10 km N of Waramadan, coord. 5°57'N, 60°45'W, alt. c. 800 m, 28. Febr. 1985, H. Sipman & A. Aptroot 19478 (B).

DIAGNOSIS: Thallus laxe adnatus, pallide cinereus, ad c. 12 cm diametro; lobi apicibus rotundatis 9-12 mm latis, marginibus crenulato-undulatis, ciliati; soralia, lobuli, pustuli isidiaque nulla, cum verrucis ciliatis; cilia numerosa, nigra, ad 3 mm longa; verrucae 0.2-0.4 mm latae, primo conicae, demum semiglobosae vel applanatae et granulis instructae; latus superior emaculatum, planum vel in centro rugulosum; medulla alba; latus inferior ad apices fuscum nudum, in centro ater, rhizinis sparsis vel aggregatis in partibus ad substratum appressis instructum; rhizinae nigrae, ad 1 mm longae, simplices. Apothecia et pycnidia ignota. Materiae chimicae (TLC): atranorinum, acida salazinicum et consalazinicum.

DESCRIPTION: Thallus corticolous, loosely adnate, pale grey, towards the centre more whitish, up to at least 12 cm wide; lobes with rotund or sligtly crenulate, 9-12 mm wide tips and crenulate-undulate, ciliate margins; lobules, isidia, pustules and soralia absent, ciliate warts present; cilia numerous, c. 2-3 mm long, black; warts 0.2-0.4 mm wide, at first conical, later hemispherical or flattened and producing coarse granules, often bearing one, rarely more, cilia; upper surface dull, emaculate, smooth and continuous near the tips, slightly rugulose and irregularly cracked in the central parts; medulla white, without pigment; lower surface black, near the lobe tips brown, mostly smooth and glossy, cracked, naked in a 10 mm or more wide zone at the lobe tips, with sparse rhizines or small patches of rhizines on appressed parts in the centre of the lobes; rhizines up to 1(-2) mm long, unbranched, black. Apothecia and pycnidia unknown. Chemistry (TLC): atranorin, salazinic and consalazinic acids. Colour reactions: medulla K+ yellow, soon turning red, C-, KC-, P+ orange, UV-; cortex K+ yellow, UV-.

DISTRIBUTION: So far known from two localities in the Guiana Highlands area, one in Guyana, the other in Venezuela, in low forest at 800-950 m elevation.

ADDITIONAL SPECIMEN: VENEZUELA, Estado BOLIVAR, Cerro Guaiquinima, in central part of upper plateau (near camp 4), coord. c. 5°40'N, 63°34'W, alt. c. 950 m, low, mossy forest on rocky slope towards stream, epiphytic, 5 Febr. 1990, H. Sipman 26595 (B, VEN)

NOTES: *Parmotrema verrucisetosum* is very distinctive by its ciliate warts spread over the surface. Other salazinic-acid containing *Parmotrema* species differ clearly by producing marginal (sub)soralia, coralloid isidia or being without vegetative diaspores (Hale 1965, Krog & Swinscow 1981).

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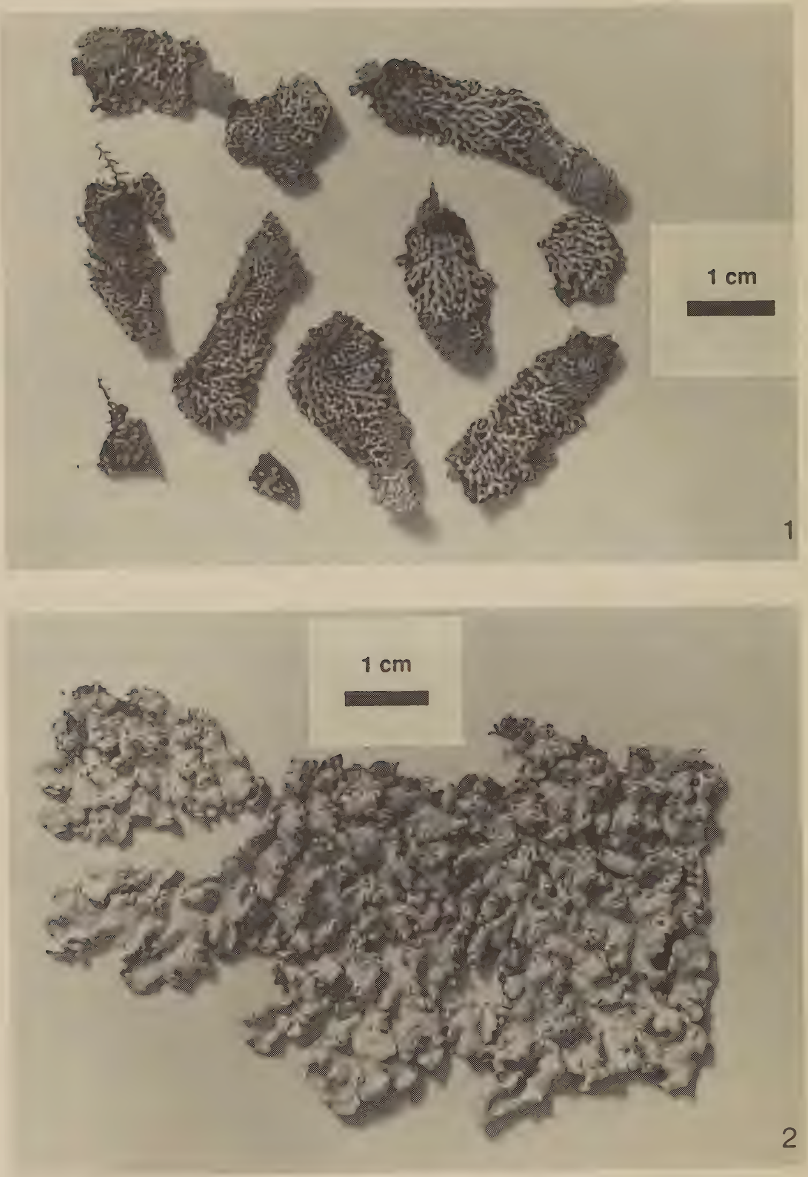
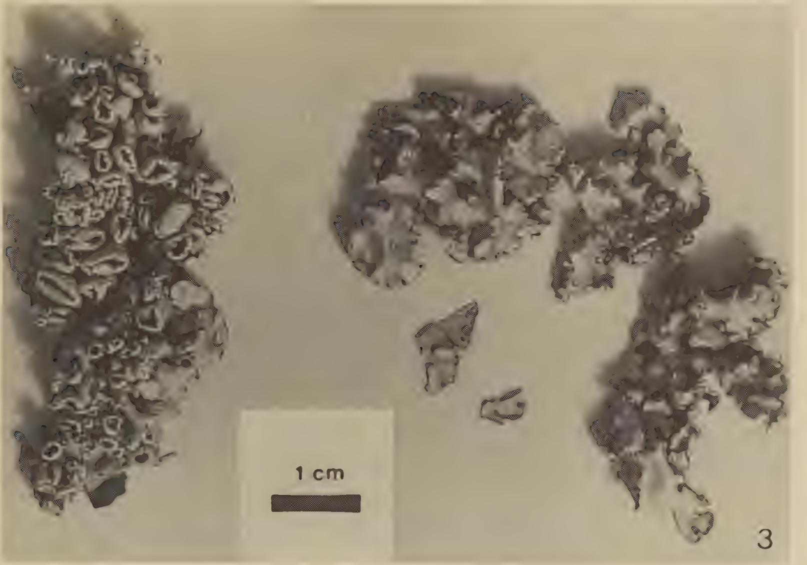


Figure 1-2: 1. *Bulbothrix leprieurii* Aubel (holotype), habitus; 2. *Parmotrema aptrootii* Aubel (holotype), habitus.



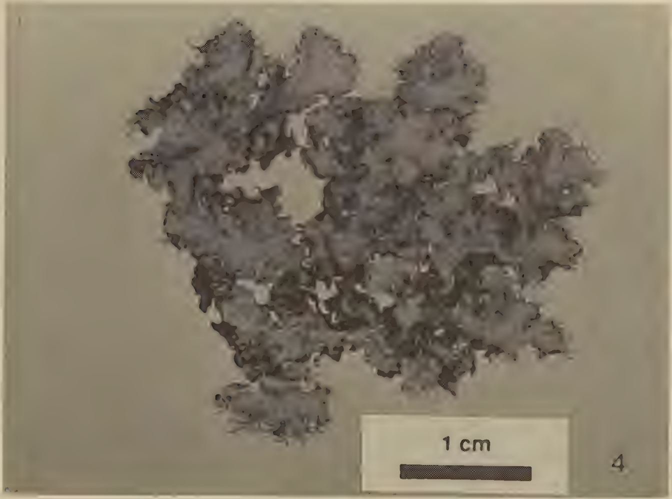


Figure 3-4: 3. *Parmotrema aurantiacoparvum* Sipman (holotype), habitus; 4. *Parmotrema gradsteinii* Aubel (holotype (left) and Aptroot 15294 (right)), habitus.

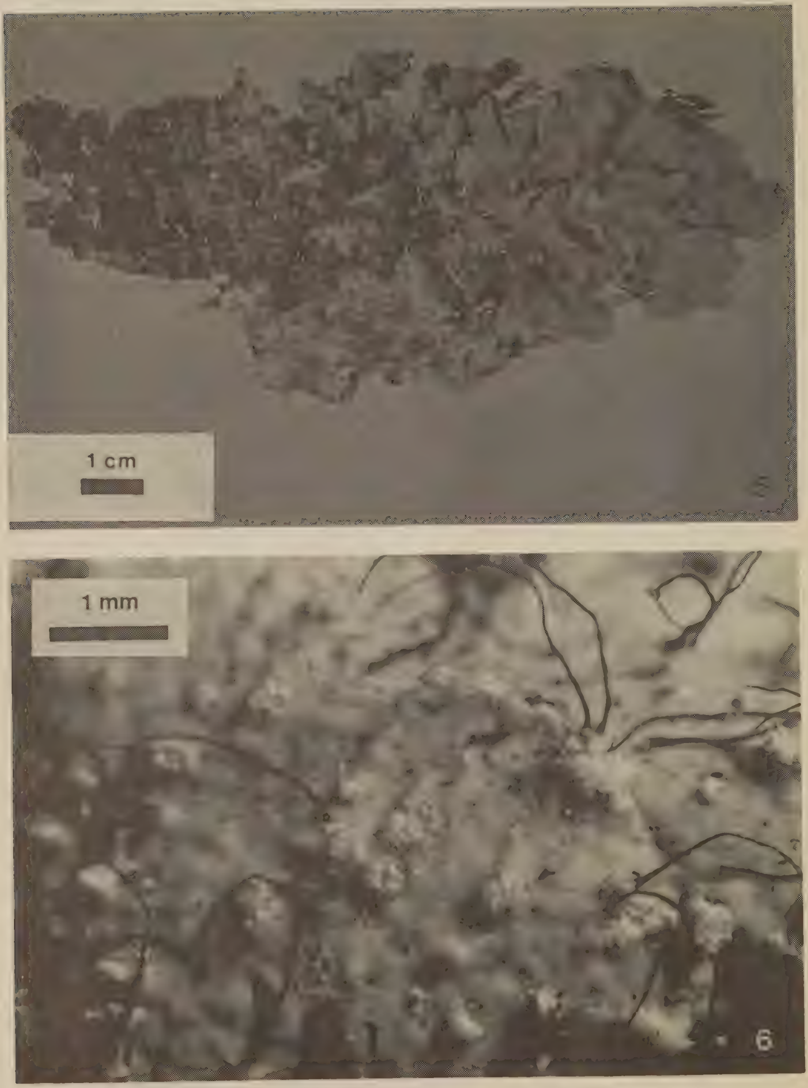


Figure 5, 6: *Parmotrema verrucisetosum* Sipman (Sipman 26595); 5, habitus. 6, detail with ciliate warts.

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ADDITIONAL NEW SPECIES AND NEW REPORTS OF PERTUSARIA (LICHENISED ASCOMYCOTINA) FROM AUSTRALIA

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ABSTRACT: The species *Pertusaria gyrophorica* Archer, *Pertusaria novaehollandiae* Archer, *Pertusaria subcerussata* Archer and *Pertusaria thamnolica* Archer are described as new; *Pertusaria cicatricosa Müll.Arg.*, *Pertusaria pertusella* Müll.Arg.and *Pertusaria porinella* Nyl., are reported as new to Australia.The published chemistry of *Pertusaria communis* var. *neo-caledonica Nyl.*, *Pertusaria plicatula* Müll.Arg. and *Pertusaria subtruncata* Müll.Arg. is revised.

INTRODUCTION

A number of new species in the lichen genus *Pertusaria* have recently been described (Archer 1991,1991a) and an examination of further specimens has shown the presence of additional undescribed taxa which are reported here. The sources of the specimens and the techniques used for the examination of specimens have been described previously (Archer 1991a); the chemistry of some taxa was also confirmed by liquid chromatography (Lumbsch & Elix 1985). The spore descriptions follow the nomenclature of Dibben (Dibben 1980:10). The figures illustrate holotypes.

Pertusaria gyrophorica Archer sp.nov. Fig.1

Thallus albidus vel cineraceus, tenuis, rimosus, superficies laevis et nitida, sorediatus sed isidiis destitutis, corticola; soralia albido-straminea, numerosa, dispersa, saepe confluentia, circularia vel irregularia, adnata, 0.4-1.0 mm diam.; apothecia disciformia, rara, marginibus incrassatis et involutis, disci concavai, albo-pruinosi, 0.5-1.0 mm diam.; asci clavate, 180-220 μm longi, 50-60 μm lati; sporae 8nae, biseriatae, ellipsoideae vel elongato-ellipsoideae, laeves, 45-55(-65) μm longae, 20-25 μm latae, parietibus *ca.* 1 μm crassis.
Thallus acidum gyrophoricum continens.
Type: Australia, New South Wales, 2 km N of Coffs Harbour, on bark of *Casuarina* along foreshore, 2 m, *J. A. Elix 1167*, 31.viii.1975; ANUC-holotype.

Thallus off-white to pale grey, thin, cracked, surface smooth and shiny, lacking isidia, sorediate, corticolous; *soralia* pale yellowish white, numerous, scattered, sometimes confluent, circular or irregular in outline, adnate, 0.4-1.0 mm diam.; *apothecia* disciform, uncommon, margins thick, inrolled, discs sunken, white pruinose, 0.5-1.0 mm diam.; asci clavate, 180-22- μm long, 50-60 μm wide; *spores* 8/ascus, biseriate, ellipsoid to elongate ellipsoid, smooth, 45-55(-65) μm long, 20-25 μm wide, wall *ca.* 1 μm thick.
Chemistry: K-, KC+ red, C+ red, Pd-; gyrophoric acid with minor amounts of lecanoric acid.

Specimens examined.
VICTORIA. Mt. Drummer, 18 km E of Cann River, on eucalypt, 360 m, *J. A. Elix 5239*, 21.xi.1978 (ANUC); track to Chatauqua Peak, 1 km N of Halls Gap, on eucalypt, *A. W. Archer P 81*, 30.x.1989 (NSW).
AUSTRALIAN CAPITAL TERRITORY. 2 km before Honeysuckle Creek Tracking Station, on eucalypt, 1000 m, *J. A. Elix 557*, 20.i.1975 (ANUC); Kowen Forest, 15 km E of Canberra, on eucalypt bark, 730 m, *J. A. Elix 1321*, 21.x.1975 (ANUC).
NEW SOUTH WALES. Brown Mountain, on eucalypt bark, 975 m, *J. A.Elix 1577*, 20.ii.1976 (ANUC); Laurieton, 30 km SSW of Port Macquarie, *G. N. Stevens 2012* p.p., 23.viii.1977 (BRIU); Tenterfield, *W. H. Ewers 3863*, 12.vii.1989 (herb. EWERS); Murphys Track, Dora Dora State Forest, 18 km SE of Holbrook, 35°51´S, 147°28´E, 620 m, on eucalypt, *J. A. Elix 23004*, 15.xi.1989 (ANUC); track by Mill Creek, ca 55 km NW of Sydney, on fallen eucalypt, *A. W. Archer P 161*, 11.v.1991 (NSW).

P. gyrophorica is one of a group of Australian sorediate *Pertusaria* taxa in the subgenus *Pionospora* which are rarely fertile and are best differentiated by their chemistry; e.g. *P. erythrella* Müll.Arg. contains norstictic acid, *P. scaberula* Archer contains lichexanthone and thamnolic acid and the saxicolous *P. persulphurata* Müll.Arg contains thiophaninic and stictic acids. *P. gyrophorica* resembles *P. subrhodotropa* Archer, described from Western Australia (Archer 1991a), but that species contains lecanoric acid as the major lichen acid and lacks soralia. Two similar sterile, sorediate specimens from Queensland [*D. Verdon 5426* (CBG, H) and *H. Streimann 37614* (B, CBG)] contained lecanoric acid as the major lichen acid and are identified as *P. subrhodotropa*. *P. gyrophorica* occurs in south-eastern Australia where it grows predominantly on eucalypts.

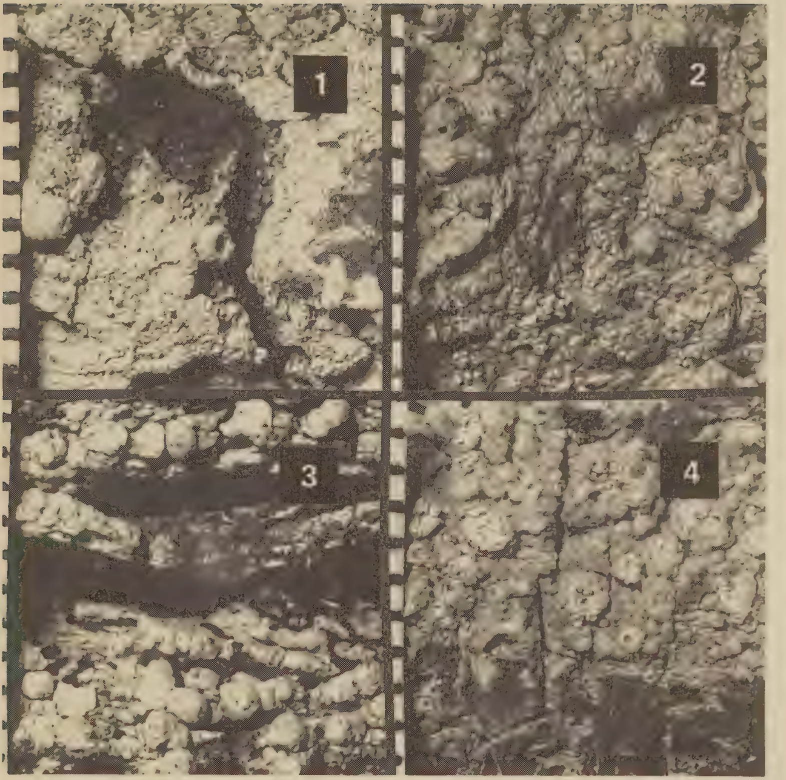
Pertusaria novaehollandiae Archer sp. nov. Fig.2

Thallus albido-olivaceus, surrimosus et subtuberculatus, superficies laevis et nitida, isidiis et sorediis destitutus; corticola; apothecia verruciformia, numerosa, dispersa, saepe confluentia, thallo concoloria, plano-hemisphaerica, basibus non constrictibus, 0.7-1.4 mm diam.; ostiola inconspicua, albido-hinnulea,saepe submammiformescentia, 0.1 mm diam., in verrucas singula; sporae 8nae, uniseriatae, laeves, ellipsoideae, fusiformescentes, 75-95 μm longae, 30-45 μm latae.
Thallus acidum miriquidicum et 4,5-dichlorolichexanthone continens.
Type. Australia, New South Wales, Cockle Creek, ca. 25 km N of Sydney, 33°40´S, 151°09´E, on *Casuarina*, 1 m, *A. W. Archer P 107*, 25.iv.1990; NSW-holotype.

Thallus pale greenish-grey, slightly cracked, subtuberculate, surface smooth and shiny, lacking isidia and soredia, corticolous; *apothecia* verruciform, numerous, scattered, sometimes confluent, inconspicuous on rough substrates, concolorous with the thallus, flattened hemishperical, not constricted at the base, 0.7-1.4 mm diam.; ostioles inconspicuous, pale fawn, sometimes becoming slightly mammiform, 0.1 mm diam., 1/verruca; *spores* 8/ascus, uniseriate, ellipsoid, smooth, becoming fusiform, 75-95 μm long, 30-45 μm wide.
Chemistry: K-, KC-, C-, Pd-; miriquidic acid and 4,5-dichlorolichexanthone.

Specimens examined.
NEW SOUTH WALES. Buckenbowra River, 7 km W of Batemans Bay, 35°42´S, 150°06´E, 1 m, on *Avicenna, H. Streimann 27783*, 29.v.1983 (CBG 8306052,H); Tomaga River Estuary, ca. 1 km S of Tomakin, 35°52´S, 150°13´E, on *Casuarina glauca, K. Kalb 21586*, 4.viii.1989 (herb. KALB); ibid., 35°51´S, 150°12´E, *J. A. Elix 23309*, 29.ix.1989 (ANUC).

The new species, characterised by inconspicuous pale fawn ostioles and the presence of miriquidic acid, is morphologically similar to *P. paragibberosa* Archer (Archer 1991a)



Figures 1-4. New species of *Pertusaria*. 1, *Pertusaria gyrophorica* ; 2, *Pertusaria novaehollandiae* ; 3, *Pertusaria subcerussata* ; 4, *Pertusaria thamnolica* .Scale in mm.

but differs chemically from that species, which contains 4,5-dichlorolichexanthone and 2'-O-methylperlatolic acid. Miriquidic acid is however closely related to 2'-O-methylperlatolic acid and is derived from that acid by oxidation of the pentyl chain in the A ring. *P. novaehollandiae* occurs in New South Wales where it grows on mangroves and coastal *Casuarinas* in contrast to *P. paragibberosa* which is predominantly an inland species.

Pertusaria subcerussata Archer sp. nov. Fig.3

Thallus albidus vel cineraceus, tenuis, rimosus, superficies laevis et nitida, isidiis et sorediis destitutus; corticola; apothecia verruciformia, numerosa, hemisphaerica vel

plano-hemisphaerica, thallo concoloria, 0.8-1.4 mm diam.; ostiola inconspicua, translucida, projecta e verrucis, ca. 0.2 mm diam., in verrucis 1-2na; sporae 4nae, uniseriatae, ellipsoideae, parietibus interioribus undulatis ("asper" sensu Dibben 1980), 90-95 µm longae, 35-50 µm latae.
Thallus lichexanthone solum continens.
Type: Australia, Queensland, Albert River Valley, S of Beaudesert, 28°10´S, 153°02´E, 200 m, on *Callitris, J. Hafellner 18464,* 1.ix.1986; GZU-holotype.

Thallus off-white to pale greyish-white, thin, cracked, surface smooth and shiny, lacking isidia and soredia, corticolous; *apothecia* verruciform, hemispherical or flattened hemispherical, concolorous with the thallus, 0.8-1.4 mm diam.; ostioles inconspicuous, translucent, projecting from the verrucae, ca. 0.2 mm diam., 1-2/verruca; *spores* 4/ascus, uniseriate, ellipsoid, rough, 90-95 µm long, 35-50 µm wide.
Chemistry: K-, KC-, C-, Pd-; lichexanthone only.

P. subcerussata is both chemically and morphologically distinct from other Australian *Pertusaria* species with four rough spores per ascus and most closely resembles *P. tetrathalamia* var. *plicatula* Müll.Arg., described from Brazil (J. Müller 1884:302); however this taxon has larger spores (125-190 µm long), 1-5 black ostioles per verruca and contains stictic acid in addition to lichexanthone. The new species is distinguished from the Australian *P. subisidiosa* Archer (Archer 1991a) by the absence of isidia and the lack of stictic acid. *P. subcerussata* is known only from the type specimen.

Pertusaria thamnolica Archer sp. nov. Fig.4

Thallus albidus vel cineraceus, areolatus et rimosus, superficies laevis et hebetata, isidiis et sorediis destitutus; corticola; apothecia disciformia, conspicua, dispersa, 0.5-1.5 mm diam., margine crasso et involuto, thallo concoloria; discus planus, albido-pruinosus; sporae 8nae, uniseriatae, ellipsoideae, laeves, 22-32 µm longae, 12-17 µm latae, parietibus *ca.* 1 µm crassis.
Thallus acidum thamnolicum continens.
Type. Australia, New South Wales. E side of Mooney Mooney Creek, ca. 8 km WSW of Gosford, 33°26´E, 151°15´S, ca. 10 m, on *Casuarina, A. W. Archer P178*, 24.v.1991; NSW-holotype; ANUC-isotype.

Thallus off-white to pale grey, areolate and cracked, surface smooth and dull, lacking isidia and soredia, corticolous; *apothecia* disciform, discs conspicuous, scattered, 0.5-1.5 mm diam., with thick inrolled margins, surface of disc white pruinose; *spores* 8/ascus, uniseriate, ellipsoid, smooth, 22-32 µm long, 12-17 µm wide, spore wall *ca.* 1 µm thick.
Chemistry: K+ yellow, KC-, C-, Pd+ yellow; thamnolic acid.

Specimens examined.
NEW SOUTH WALES.Buckenbowra River Estuary, 7.5 Km W of Batemans Bay, 35°42´S, 151°06´E, 1 m, among *Avicennia* and *Casuarina, K. Kalb 18238*, 4.viii.1988 (herb. KALB); ibid., *K. Kalb 18921* (herb. KALB).

The new species resembles *P. truncata* Krempelh. but is distinguished from that species by the presence of thamnolic acid and the slightly larger spores; *P. truncata* contains picrolichenic acid and its spores are (16-)19-27 µm long and (8-)12-14.5 µm wide. (Kantvilas 1990). It is distinguished from *P. scaberula* Archer (Archer 1991a) by the absence of lichexanthone and the esorediate thallus. The thin-walled spores and the disciform apothecia place the new species in the subgenus *Pionospora* as defined by Dibben (Dibben 1980:38). The species is so far known only from the two localities in New South Wales.

NEW RECORDS

Pertusaria cicatricosa Müll.Arg. Proc. Roy. Soc. Edinburgh 11:461 (1882).
Type: Socotra, Balfour s.n., 1876; G-lectotype (here selected).

Pertusaria communis var. *neo-caledonica* Nyl. Bull. Soc. Linn. Normandie ser. 2,2:70 (1867).
Type: New Caledonia, Wagap, Plancher s.n., 1862; H-NYL 22885 [published as 22855 (Archer 1991)] lectotype.

Pertusaria subtruncata Müll.Arg. Flora 67: 397 (1884).
Type: Mauritius, Robillard s.n., 1876; G-holotype.

Thallus pale yellowish white to pale yellowish green, slightly tuberculate and cracked, surface smooth and dull, lacking isidia and soredia, corticolous; apothecia verruciform, concolorous with the thallus, conspicuous, numerous, crowded, sometimes confluent, flattened hemispherical, often irregular in outline, sometimes becoming constricted at the base, 0.8-1.5 mm diam.; ostioles inconspicuous, pale brown or translucent, 0.1-0.2 mm diam., 1 or less frequently 2-3/verruca, sometimes slightly sunken; spores 2/ascus, ellipsoid, rough, 100-140(-155) μm long 35-50 μm wide.
Chemistry: K-, KC-, C-, Pd-; 2,4,5-trichlorolichexanthone, 2,4- and 2-5-dichlorolichexanthones, stictic acid and constictic acid (tr).

Specimens examined.
AUSTRALIA, Queensland. Brisbane, Tingalpa Creek, *F. R. M. Wilson s.n.*, 18.viii.1896 (NSW L4640 p.p.);North Stradbroke Island, 2 km N of Dunwich, on *Avicennia marina*, sea-level, *R. W. Rogers 1999*, 10.viii.1972 (BRIU 2052); Noosa Heads National Park, in rain forest on fallen branches, 20 m, *J. A. Elix 10380*, 31.viii.1982 (ANUC)
VANUATU. s. loc.,*F. R. M.Wilson s.n.*, 1895 [as New Hebrides] (NSW L4656, L4657); Malekoula Is., Port Sandwich, Planter Point, *D. Tippet 61*, 19.viii.1985 (NSW).
FIJI. Viti Levu, Coral Coast, Tagaque Village, 20 km E of Sigatoka, on coconut palm, *J. A. Elix 15321*, 29.viii.1983 (ANUC).

The earliest name for this taxon is *Pertusaria communis* DC var. *neo-caledonica* Nyl. (Nylander 1867) but this variety is chemically and morphologically distinct from *P. pertusa* (Weigel) Tuck. (syn. *P. communis* DC), which contains 4,5-dichlorolichexanthone and stictic acid (Hanko 1983:114) and has smooth walled spores; specific status is therefore appropriate for this taxon. When var. *neo-caledonica* is raised to species level the earliest name is *P. cicatricosa*. Müll.Arg. Müller himself had noted the similarity of his new species with var. *neo-caledonica* in the protologue to *P. cicatricosa* (Müller, loc.cit.). Liquid chromatography showed that the previously reported xanthone (Archer 1991, 1991a) present in var. *neo-caledonica* and *P. subtruncata* Müll.Arg., i.e. 4,5-dichlorolichexanthone, is a mixture of chlorinated xanthones (vide supra); this combination of related tri- and di-chlorolichexanthones was first reported from *P. aleianta* Nyl. (Huneck & Höfle 1978).

P. cicatricosa was described from material collected on the island of Socotra and the protologue refers to two syntypes collected by Balfour and Schweinfurth respectively (Müller 1882). The specimen collected by Balfour has two rough spores per ascus, as described in the protologue and is chosen as lectotype. The specimen collected by Schweinfurth however has two smooth spores per ascus and contains thiophaninic and stictic acids; it resembles *P. subflavens* Müll.Arg., also described from Socotra (Müller loc. cit.). *P. cicatricosa* was also reported from Ceylon and New Caledonia (Müller 1884) and the specimens (from the Müller herbarium) corresponding to this report were examined. The specimen from Ceylon [Thwaites s.n., 1876 (G)] has two rough spores per ascus but the specimen from New Caledonia [Balaba(?), Vieillard s.n.,(G)], labelled "*P. communis* var. *neo-caledonica* Nyl.", has two smooth, fusiform spores per ascus and contains 4,5-dichlorolichexanthone and can be identified as *P. irregularis* Müll.Arg., previuosly described from Australia (Müller1895; Archer 1991). Müller later referred to a further specimen of *P. cicatricosa* collected in New Caledonia by T. Saves in 1886 (Müller 1887) but this specimen was not seen.

P. subtruncata was described from Mauritius and the type specimen is identical both chemically and morphologically to *P.cicatricosa. P. goniostoma* Müll.Arg. (Müller 1884:285) may also be a later name for *P. cicatricosa;* the holotype of that species [New Caledonia, s. loc., *Vieillard s.n.*,1883 (G)] has two rough spores per ascus but was too small for chemical examination.

P. cicatricosa is characterisd by the two rough spores per ascus and the presence of tri-and di-chlorolichexanthones and stictic acid; it is differentiated from the chemically similar *P. pertusella* Müll.Arg.(q.v.) by the rough spores (smooth in the latter taxon). *P. cicatricosa* is a tropical to subtropical species which, in Australia, occurs in eastern Queensland.

Pertusaria pertusella Müll.Arg. Flora 67: 283 (1884).
Type: Mauritius, *Robillard s.n.*, 1876; holotype-G.

Pertusaria plicatula Müll.Arg. Bull. Herb. Boissier 3: 635 (1895).
Type: Australia, Queensland, s. loc., *Knight 41* p.p., 1887; holotype-G.

Pertusaria straminea Müll.Arg. ibid. p. 638.
Type: Australia ,Queensland, Thursday Island, *Hartmann s.n.*, 1887; holotype-G.

Thallus off-white to pale yellow green, areolate and cracked, surface slightly wrinkled and dull, corticolous; verrucae conspicuous, numerous, sometimes confluent, slightly flattened hemispherical, becoming constricted at the base, 0.5-1.0 mm diam.; ostioles inconspicuous, pale to dark brown, 1-5/verruca, often slightly sunken in the verruca; spores 2/ascus, elongate ellipsoid, smooth, 100-140(-160) μm long, 30-40(-45) μm wide.
Chemistry: K-, KC-, C-, Pd-; 2,4,5-trichlorolichexanthone, 2,4- and 2,5-dichlorolichexanthones and stictic acid and constictic acid (tr).

Additional specimen examined.
Australia, Northern Territory, 60 km S of Darwin, Darwin River, on *Brugiera, N. Sammy 87/035*, 19.ii.1987 (DNA 30327).

The specimens previously described as *P.plicatula* Müll.Arg. (Archer 1991) are also *P. pertusella.* The taxon is characterised by the two spored asci and the presence of tri- and dichlorolichexanthones and stictic acid; it is differentiated from the similar *P. cicatricosa* (q.v.) by the two smooth spores per ascus. *P. pertusella* occurs in northern and north-eastern Australia and Vanuatu, and has been reported from India (Müller 1892) and also from Queensland (Shirley 1889) but the specimen corresponding to the latter report was not seen.

Pertusaria porinella Nyl. Ann. Sci. Nat. Bot. (4) 19: 321 (1863).
Type; Mexico, Tampico, *Uzac s.n.*, 1858; holotype H-NYL 22966

Thallus thin, dull yellowish white to off-white, surface smooth and dull; corticolous; apothecia verruciform, concolorous with the thallus, numerous, scattered. rarely confluent, flattened hemispherical, sometimes becoming constricted at the base, 0.4-0.8 mm diam.; ostioles inconspicuous, translucent, 1/verruca; spores 2/ascus, ellipsoid, smooth, (75-)85-105(-112) μm long, 25-40 μm wide.

Chemistry; K- or weak yellow, KC-, C-, Pd- or weak yellow; stictic acid, ± constictic (tr) and cryptostictic acids (tr), ± lichexanthone.

Specimens examined:
Australia, Queensland. North Stradbroke Island, S of Dunwich, on *Avicennia*, sea-level, *R. Rogers 534*, 21.ii.1975 (BRIU); Noosa River [near Noosa Heads], on *Brugiera*, sea-level, *G. N. Stevens 2373 p.p.*, 18.xii.1975 (BRIU).
New South Wales. Sawtell [near Coffs Harbour], Boambie Creek, on *Avicennia*, sea-level, *G. N. Stevens 2042*, 24.viii.1977 (BRIU); Erina Creek, 3 km E of Gosford, on *Avicennia marina*, sea-level, *J. A. Elix 4714*, 8.v.1978 (ANUC); ibid., *J. A. Elix 4709b*, 8.v.1978 (ANUC).

P. porinella is distinguished from other two-spored Australian *Pertusaria* species with stictic acid by the absence of chlorinated xanthones and the presence of translucent ostioles. The taxon was reported to occur in Ceylon (Singh 1964:185) but the reference quoted (Müller 1884: 398) refers to the occurence of the taxon in San Diego, California. *P. porinella* was reported from Queensland (Bailey 1883) but the specimen corresponding to this report was not seen. In Australia *P. porinella* occurs on coastal mangroves from southern Queensland to northern New South Wales .

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CONTRIBUTION TO THE STUDY ON THE GENUS SINOTERMITOMYCES FROM ASIA

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ABSTRACT Two new edible mushroom species : *Sinotermitomyces griseus* Zang and *Sinotermitomyces rugosiceps* Zang are described and illustrated from a collection on termite combs from Burma. The type specimens of the two species are deposited in the Cryptogamic Herbarium, Kunming Institute of Botany, Academia Sinica (HKAS).

KEY WORDS: *Sinotermitomyces rugosiceps*, *Sinotermitomyces griseus*.

汉 文 摘 要

本文报道了华鸡坳属两新种，即:糙盖华鸡坳 *Sinotermitomyces rugosiceps* Zang和灰色华鸡坳 *Sinotermitomyces griseus* Zang均采自缅甸,模式标本均存于中国科学院昆明植物研究所隐花植物标本馆(HKAS) 撰摘人:臧 穆

The genus *Sinotermitomyces* Zang (Amanitaceae) is mainly restricted to Eastern and South eastern Asia monsoon forest, while only two original species: *Sinotermitomyces cavus* Zang and *Sinotermitomyces carnosus* Zang occur in tropical region of South western Yunnan and South eastern Tibet,China.(Zang, 1981). Recently, in Burma, the knowledge of this genus is quite limited and all the known another two relative species have been founded in *Quercus* and coniferous forests. The genus is well defined by a long tubelike tapering stipe buried on the termite combs below the ground. The Asian and Chinese people are popularly known as the edibility use of termite mushrooms and the distinctive mushrooms are grouped according to the special habitat, (Wang, 1985). The different termite combs where the termite fungi (e.g. *Sinotermitomyces* and *Termitomyces* etc.) are most likely to be found. The genus *Termitomyces* is a common genus during the rainy season in South and Southeast Asia and tropical Africa (Heim, 1977; Batra, 1979)

Taxonomic and Geographic distribution part

Sinotermitomyces Zang, Mycotaxon 13(1): 171. 1989.
Type species: *Sinotermitomyces cavus* Zang.

Key to the known species of genus Sinotermitomyces in Asia

1.Stipes leathery to fibrillose tubelike,equal,exact hollow 2

1.Stipes fleshy to fibrillose, clavate, tepering towards the base,stuffed or hollow...................................3

2.Pileus conical, glabrous,basidiospores smaller, 2.4-5 X 3.5-9 um .... 1.Sinotermitomyces cavus

2.Pileus subumbonate,rugose, covered with warts, basidiospores larger, 6.5-10 X 6.5 um ...... 4. S. rugosciceps

3.Pileus conical to plano-convex , pale white to brown,scabrous separated, without holes at the center, basidiospores smaller, 4.9-8 X 3-6 um ....2. S. carnosus

3.Pileus hemispheric,slightly umbonate, ivory grey to griseous brown, pierced with holes at the center, basidiospores larger, 9-11.7 X 6.5-8 um ....3. S. griseus

1. Sinotermitomyces carnosus Zang, Mycotaxon 13(1) : 172. 1981.(Fig. 9.)

China : Yunnan, Tsangyuan County, On termites nest. 30. VIII.1980. M. Zang 6752 (HKAS 6752).

2. Sinotermitomyces cavus Zang, Mycotaxon 13(1) : 172. 1981. (Fig. 9.)

China : Yunnan, Tengchung County, Tuan-Tian Village, on nest of termites, 2100 m. alt. 8 VIII 1980. X.J. Li 11 (HKAS 6533); Tengchung County , Pu-Chuan village, X. X. Ma 1. (HKAS 4612); Mangshi, 10 . VIII 1980. M. Zang 6545 . (HKAS 6545); Shweli County. on nest of termites, 12 VIII 1980. M. Zang 6563 (HKAS 6563);Jing Gu County. 10 VII 1985. K.Y.Guan 1. (HKAS 14626). Tibet (Xizang) : Motou, 2610 m. alt. 25.IX. 1985. R. G. Su 1343 (HKAS 16253).

3. Sinotermitomyces griseus Zang, sp. nov. (Fig.1-4, 9)

Pileus 3-4 cm., conicus vel umbonatus, convexus, siccus, scabridus. primo albidus vel eburneus, demum griseus vel fulvo-ravidus. Lamellae subliberae vel adnatae, albidae vel eburneae. Stipes 25-30 cm longus, 0.6-1 cm crassus, aequalis,carnosus vel fibrillosus, tubulosus, apice glabriusculus vel furfuraceus, griseus, deorsum laevigatus, badius. Annulus superus distinctus, cernuus. Stipes deorsum annulatus, parte stipitis urtra annula solido, inferiore cavo. Basidiosporae 9-11.7 X 6.5-8 um, hyalinae,globosae,ovoideae, laeves, inamyloideae. Basidia 15-20 X 8-10 um, clavata, 4 -sporigera. Pleurocystidia 18-26 X 7-11 um, cylindrica, fusiformis. Cheilocystidia 15-20 X 10.4-11.7 um late fusiformis. Hab. In sylvis mixtis coniferarum et Quercorum, ad terram in silva pluviali, nido Termitidarum (Odontotermes) erumpente.

Burma : Popa Mountain Park, The Union of Myanmar, Mandalay division. Under Conifers and Quercus forests, in red clay on nest termites, 23 X 1991. K.Y. Guan 2. (HKAS 23648,Typus).

Pileus 3-4 cm broad, hemispheric becoming convex, dry,occasionally obtusely conic, slightly umbonate when expanded, whereabouts pierced with small holes at the center when mature, minutely scabrous, surface white to griseous brown on margin and also becoming translucent-striate toward margin appressed. Context thin and rather firm, white, not changing color when cut or bruised. Gills crowded, almost free or adnate, white to near ivory white. Stipe 25-30 cm long, 0.6-1 cm thick, equal, tubelike, fleshy upward, fibrillose below. Annulus superior persistent as a floccose-membranous white collapsing hanging down loosely around the stipe, solid above the annulus, hollow below, upwards often covered with bran-like scales on the surface, glabrous at the below and with a discoid base. Basidiospores 9-11.7 X 6.5-8 um, hyaline, globose, ovoid, smooth, inamyloid. basidia 15-20 X 8-10 um, clavate, 4-spored. Pleurocystidia 28-35 X9-14 um, cylindric to fusiform. Cheilocystidia 19.5-30 X 10 14 um. broadly fusiform.

The most distinctive character of this grayish species and its stipe that is a different texture, the uppers is solid, the lower is hollow. The another distinctive characters are that the pileus with slightly umbonate and pierced with small holes and the larger basidiospores, however it is easily separate from Sinotermitomyces carnosus Zang.

4. Sinotermitomyces rugosiceps Zang, sp. nov. (Fig. 5-8,9)
Pileus 3.5-4.5 cm. conicus, campanulatus vel subumbonatus, convexus, siccus, verrucosus. Primo pallidus, demum cervinus vel brunneus. Lamellae liberae vel subliberae, albidae. Stipes 25-35 cm longus, 0.8-1.5 cm crassus. aequalis, cavus, tubulosus, coriaceus vel fibrillosus, apice laevigatus, sursam scabroso-furfuraceus, basim versus discoideus. Annulus superus distinctus, valvatus sursum. Basidiosporae 6.5-10 X 5-6.5 um , hyalinae, ovoideae, ellipsoideae, laeves,in solutione Melzeri aureo-brunneolae. Basidia 11-15.6 X 7-8 um. clavata, 4-sporigera. Pleurocystidia 16-22 X 8-9.5 um,cylindrica. Cheilocystidia 17-20 X 8-9 um, cylindrica.
Hab. In sylvis, ad terram in silva pluviali, nido Termitidarum (Odontotermes) erumpente.
Burma : Pyin Oo Lwin 1000 m. alt. The Union of Myanmar,Mandalay Division. under Monsoon forests. 22 X 1991. K.Y.Guan 1. (HKAS 23647 Typus)

Pileus 3.5-4.5 cm broad, conical, campanulate, subumbonate or convex, dry, surface white or pale white to waxy yellow or brown, covered with brownish pyramidal warts, which later may fall off or be washed off. Gills free or subfree, white. Stipes 25-35 cm long, 0.8-1.5 cm thick, equal, hollow, tubelike, leathery to fibrillose, glabrous above the annulus,minutely scurfy below and with a discoid base. Veil persistent as a thick, membranous leathery upwards annulus. Basidiospores 6.5-10 X 5-6.5 um, hyaline, ovoid to ellipsoid, smooth, color near golden-brown in Melzer's reagent . Basidia 11 -15.6 X 7-8 um, clavate, 4-spored. Pleurocystidia 17-20 X 8-9.5 um, cylindric. Cheilocystidia 17-20 X 8-9 um, cylindric.

Sinotermitomyces rugosiceps is a fairly edible fungus, well characterized by the pileus covered with pyramidal warts, the larger size basidiospores and the hollow stipe. The similar species in which the stipe also hollow is Sinotermitomyces cavus Zang, which has a glabrous pileus and the smaller size basidiospores (3.5-9 X 2.4-5 um)

ACKNOWLEDGEMENTS

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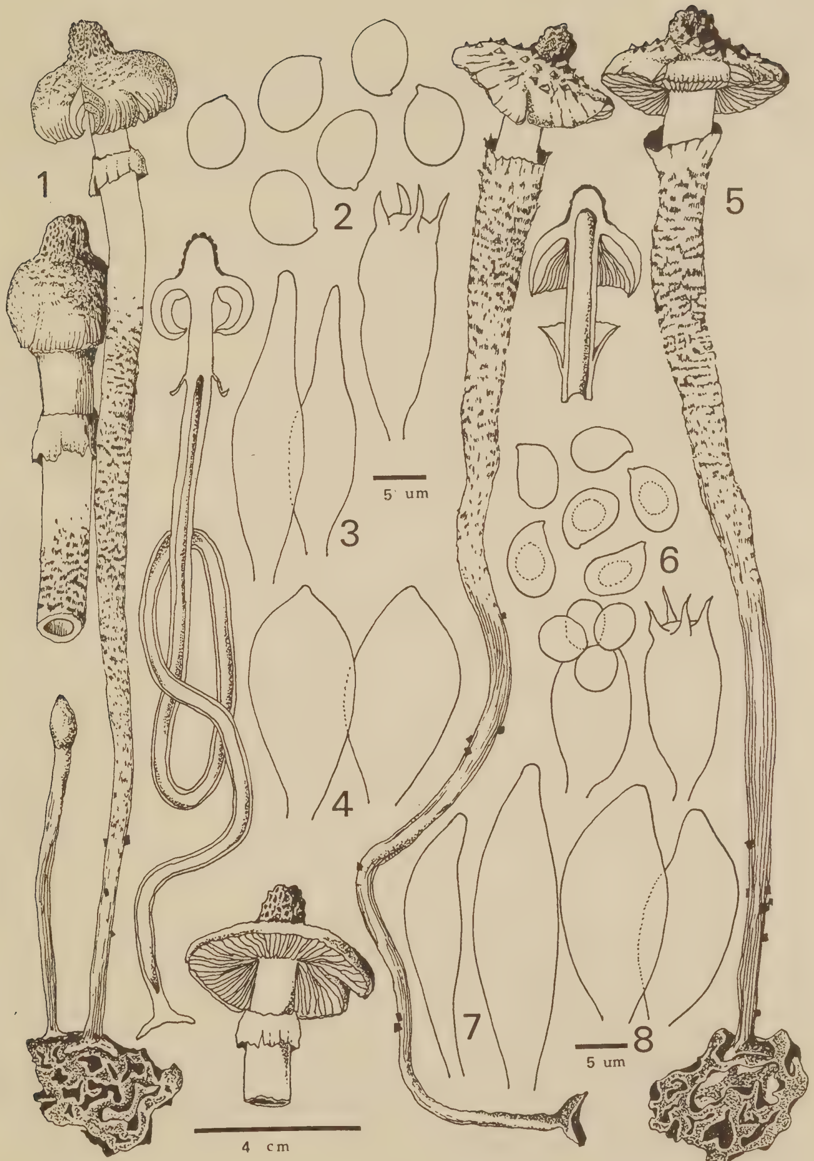

Figs. 1-8. Sinotermitomyces griseus Zang : 1. Basidiocarps; 2. Basidium; 3. Pleurocystidia; 4. Cheilocystidia.
Sinotermitomyces rugosiceps Zang : 5. Basidiocarps; 6. Basidia and basidiospores; 7. Pleurocystidia ; 8. Cheilocystidia.

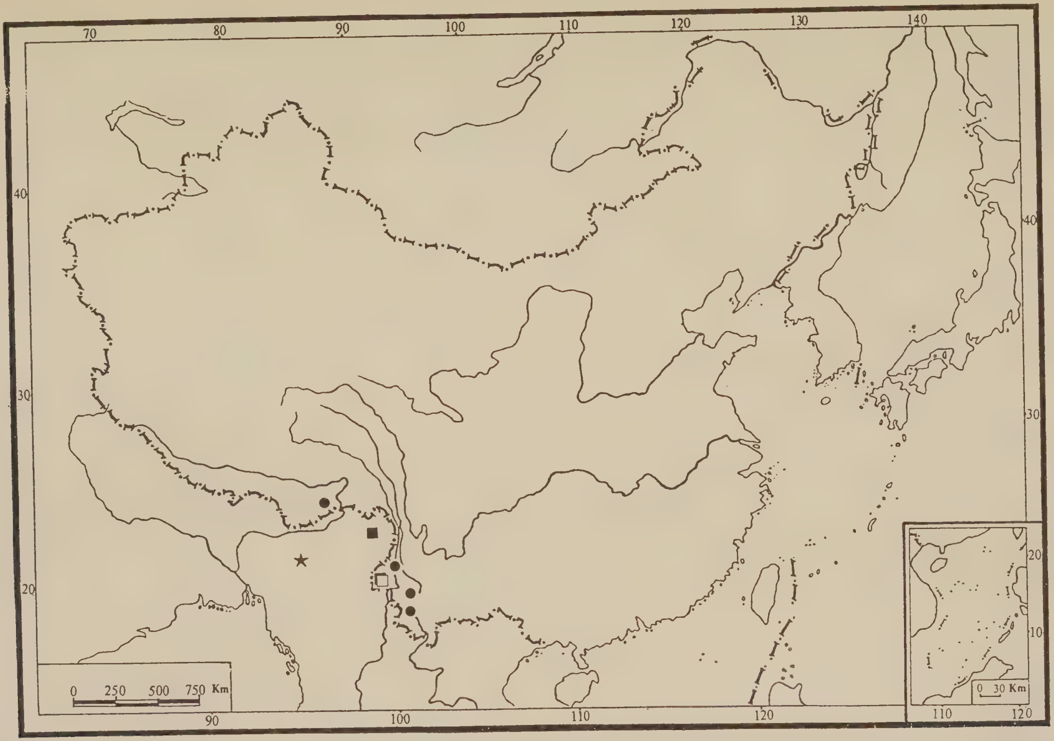
70
80
90
100
110
120
130
140
40
30
20
0 250 500 750 Km
0 30 Km
10

Fig. 9. Geographic distribution pattern of Genus *Sinotermitomyces*. ● *S. cavus*; □ *S. carnosus*; ★ *S. griseus*; ■ *S. rugosciceps*.

MYCOTAXON

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ECOLOGY AND TAXONOMY OF THE GENUS LEPISTA IN SARDINIA. 2. LEPISTA MASIAE sp. nov., A NEW ADVENTITIOUS SPECIES.

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SUMMARY

A new basidiomycetes species, Lepista masiae sp. nov., is described from Sardinia (Italy). Due to its micromorfological characters L. masiae is placed in the subgenus Rhodopaxillus (R. Maire) M. Bon.

KEY WORDS

Basidiomycetes, Agaricales, Lepista, Sardinia.

Records of exotic agaricomycetes are not very rare in Sardinia, especially in suitable places such as botanical gardens and pot of flowers (Ballero et al., 1991).

During the last season a lot of very interesting basidiomycetes were observed in many station of the Isle southern area Chlorophyllum molybdites (G.F.W. Meyer: Fr.) Mass., Agaricus haematosarcus Hein. et Gooss., Lepiota micropholis (Berk. et Br.) Sacc. , Sericeomyces viscidulus Hein., Leucoagaricus rubrotinctus (Peck) Sing. etc. and one of the new for the science recorded entities is the subject of this comunication.

This is a Lepista species which has been collected over several ways in a pot of flowers by our friend M. Masia who kindly sent us four collections. We feel necessary to propose the following new taxon.

Lepista masiae Ballero & Contu sp. nov.

Pileus 1-3 cm latus, carnosulus, explanatus, ad medium interdum levissime umbonato, margine involuto, exstriato, sine vestigia veli; cutis parce separabilis, leviter hygrophana, tomentosa, radialiter fibrillosa-virgata, obscure griseo-brunnea, fibrillis obscurioribus.

Lamellae tenues, remotae, decurrentes, pallidae dein ochraceo-luteolae, interdum leviter roseotinctae. Stipes 2-4.5 x 0.5 -1.4 cm, pileo confluens, solidus, plenus, subcylindraceus vel clavatus, ad basim saepe radiculis albidis mycelii obtecto; indumentum siccum, leviter costolatum, saepe fibrillosum, superne pruinosum, album. Caro sat conspicua, alba, immutabilis, odor saporque debilis.

Sporae 4.8-6 x 3.3-4.1 mu, hyalinae, cyanophilae, ellipsoideae, echinulatae, crassotunicatae. Basidia 22.5-36 x 7-7.5 mu, tetraspora, clavata, fibulata. Lamellarum trama subregularis. Cystidia nulla. Pilei cutis ex hyphis pro parte erectis efformata, pigmento intraparietalis praeditis. Fibulae numerosae.

Ad terram, gregaria vel subcaespitosa sub Ficus benjamina L. lecta. Autumno.

Typus: Italia, Sardinia meridionalis, Cagliari, sub Ficus benjamina L. , 19-9-1990. Legit M. Masia, det. M. Ballero & M. Contu (HOLOTYPUS, n° 90/52, in CAG).

Cap 1-3 cm broad, fleshy, explanded with a slightly umbonate centre, margin inrolled, not striate; surface slightly hygrophonous, tomentose to radially fibrillose, not viscid, dirty brown with fuscous shades near the centre.

Stipe 2-4.5 x 0.5-1.4 cm, confluent with the cap, solid, sub-cylindrical to clavate, at the base often with white. Mycelium remmnants, flesh rather thick, white unchanging; small and taste not distinctive.

Spore-print not obtained. Spores 4.8-6 x 3.3-4.1 mu, hyaline, ellipsoid, cyanophilous, strongly echinulate, thick walled, white with a small apiculus. Basidia 22.5-36 x 7-7.5 mu, four-spored, clavate, with clamps.

Hymenophoral trama subregular, made up of cilindrical, slightly pigmentate hyphae, ut to 10.5 mu broad. Cystidia of any kind none. Pileal surface a dry trichoderm mode up of cilindrical to slightly clavate up to 4.8 mu broad hyphae; connection present on all septa.

Habitat: gregarious to caespitose in a pot of flowers containg Ficus benjamina L. (Moraceae)

Material examined - Italy: south Sardinia, Cagliari, in a pot of flowers with Ficus benjamina, n° 90/52 19-9-1990, legit M. Masia, det. M. Ballero & M. Contu (holotypus); ditto, 7-10-1990 n° 90/55; ditto 29-10-1990 n° 90/184. Material in CAG.

DISCUSSION

According to M. Bon's recent treatment (1983) of the european representatives of Lepista this new species belongs to the subgenus Rhodopaxillus (R. Maire) M. Bon although spore size and ornamentation show a close resemblance to that of L. inversa (Scop.) Pat. and other taxa usually placed in Lepista sectio Gilva Harmaja (syn. Lepista sectio Inversae Sing. et Clemençon nom. inv.).

Among the entities of the subgen. Rhodopaxillus L. panaeola (Fr.) P. Karst. is comparable but discrepancies in cap colours, spore-size and ornamentation are clearly decisive.

Concerning the extra-european Lepista we have not been able to find a taxon covering the specimens studied (Bigelow and Smith, 1969). L. panaeoliformis (Murr.) Sing., thus far known only from type collection, came closest but it is clearly different in having paler colours and bigger spores.

Conseguently L. masiae (dedied to our friend Prof. M. Masia) will be easy to recognize if eventually collected out of Sardinia. This, in our opinion, should be probable because macromycetes growing in pot of flowers (Ballero e Contu, 1991) have, at least in Sardinia and with a few exceptions, an exotic origin and their introduction in such country is tied to very peculiar circumstances and, definitively has to be retained as an exceptional event.

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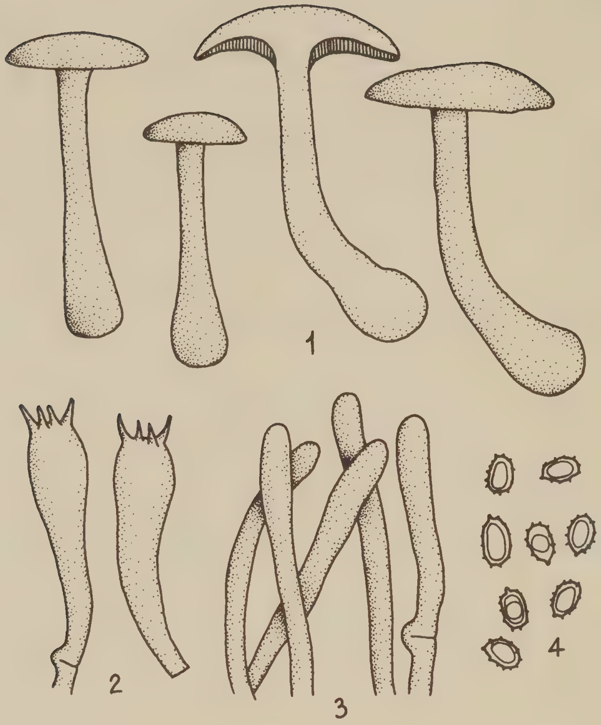

Lepista masiae sp. nov.

1) carpophores 2) basidia 3) pileal surface structure

4) spores

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NOTES ON SPANISH LEAF-INHABITING HYALOSCYPHACEAE

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Summary: One new genus and a new species of the Hyaloscyphaceous fungi are described: *Graddonidiscus* Raitv. & Galán for *Dasyscyphus coruscatus* Graddon and a new species *Graddonidiscus hispanicus* Raitv. & Galán on *Quercus* leaves. The taxonomic position of the new genus is discussed. *Lachnum trapeziforme* Vel. and *Hyaloscypha carpinacea* Vel. are recollected from Spain on *Quercus* and on *Alnus* leaves respectively. Their taxonomic positions are discussed and a new combination *Phialina carpinacea* (Vel.) Raitv. & Galán is proposed.

METHODS

Microscopic studies (squash mounts) were made using Melzer's reagent or Lactophenol-Methyl Blue with pretreatment in 5% KOH solution and directly photographed. Photomicrographs were made with a Nikon microscope (Optiphot model with an incorporated automatic system) using phase contrast (figs. 2-5, 7, 13, 21 & 25) or interferential contrast-Nomarski (figs. 12, 14, 15, 20 & 23). All measurements and line drawings were made with Carl Zeiss Jena microscope equipped with a drawing tube.

The specimens are preserved in the private herbarium of the first author (**RG**), deposited at the Herbarium of the University of Alcalá de Henares.

Lachnum trapeziforme Vel. Mon. Disc. Boh. 261 (1934). (Figs. 1-11).

Apothecia scattered or in small groups, stipitate, cup-shaped, up to 0.3 mm in diameter. Receptacle and and disc pure white, not changing after drying. Receptacle covered by white hairs. Stalk cylindrical, its length more or less equal to the diameter of the disc, 0.1 mm in diameter. Ectal excipulum composed of "textura prismatica", individual cells hyaline, thin-walled, about 11x5 μm. Hairs cylindrical with slightly tapering rounded tips, occasionally with a swollen basal cell, straight, 2-4-septate, hyaline, thin-walled but sometimes with a restricted lumen, finely granulate, bearing large crystals of calcium oxalate and apically agglutinated by large globules of amorphous matter, 60-70x3-4 μm. Asci arising from simple septa, cylindrical-clavate, with J+ apical pore, 8-spored with irregularly biseriate arrangement of the spores, 56x6.2-7.4 μm. Spores ellipsoid to clavate-ellipsoid, inequilateral, straight to slightly curved, very variable in their shape, hyaline, aseptate, 8-10.5x2.5-3.7 μm. Paraphyses narrowly lanceolate, slightly exceeding the asci, 2.5 μm in diameter.

On fallen leaves of *Quercus*.

Specimen examined: On fallen leaves of *Quercus faginea* Lam. ?, Arroyo de Fardes, Alfaguara, Granada, Spain, 21.11.1989, coll. A. Ortega et al. (**RG**-6565). On decaying leaves, Lightcliffe, Halifax, England, 15.10.1894, s.n. *Dasyscypha echinulata* (Rehm) Sacc. in Herb. Crossland (**K**).

This species is related to *L. rhytismatis* (Phill.) Nannf. but differs from it clearly in ascus and spore size. The fungus described by Dennis (1949: 29) as a "reduced form of *Dasyscypha soppitii* Massee" represents the same species. The collection at **K** is very scanty and contains only 3 apothecia in bad condition. So it was not sectioned but the original drawings on the label show quite clearly the identity of Crossland's collection to Velenovsky's species. Velenovsky's type of *L. trapeziforme* has been not available but Dr. B. Spooner (personal communication) agrees, that this name can be used for the described taxon.

Phialina carpinacea (Vel.) Raitv. & Galán comb. nov. Basionymum: *Hyaloscypha carpinacea* Vel. Mon. Disc. Boh. 273 (1934). (Figs. 12-19).

Apothecia gregarious, cup-shaped to discoid with well-defined margin, up to 0.3 mm in diameter, subsessile to shortly stalked (profile more or less conical in section), seated on a brown circle. Receptacle and disc white in fresh condition, pale yellow when dry. Margin and flanks (in minor degree) covered by short white hairs. Excipulum composed of "textura prismatica" to obscurely "textura angularis". Individual cells hyaline but brownish in the basal ring, thin-walled, prismatical to barrel-shaped, sometimes angular or quadrangular, relatively shorter in the basal region and relatively longer toward the margin, 7.4-12.4x4.3-6.2 μm. Hairs conical to cylindric-fusoid, mainly flexuous, never branched, hyaline, thin-walled, 2-4-septate, smooth in their lower part but granulate in one or two upper cells, 30-65 μm long, 4-5 μm in diameter in the widest part. Apical cells of hairs possess yellowish oily inclusions. Asci arising from the croziers, clavate to cylindric-clavate, sometimes stalked, with strongly J+ apical pore, 8-spored with biseriate or obliquely uniseriate arrangement of spores, 31-55x6.2-7.4 μm. Ascospores elliptic-fusiform, usually inequilateral and slightly curved, hyaline, aseptate, 13-16x2.4-2.6 μm. Paraphyses cylindrical-clavate, branched at the base, scarcely septate, not or very slightly exceeding the asci, apically 2-3.7 μm in diameter and containing yellowish oily inclusions.

On fallen decaying leaves of deciduous trees emerging on both surfaces from nerves or parenchyma.

Specimen examined: On dead leaves of *Alnus glutinosa*, Bridge on the "Arroyo de Barbaón", Parque de Monfragüe, Cáceres, Spain, 15.11.1986, coll. R. Galán & M. Jiménez (Holotype **RG**-6532).

The identity of the Spanish material to Velenovsky's species was confirmed by Dr. Seppo Huhtinen (personal communication). We had some difficulties in finding an appropriate genus for this peculiar species because it has an unusal combination of characters.

The brown stromatic basal ring is characteristic of *Calycellina* Höhn. but this genus in the sense of Lowen & Dumont (1984) not Baral (1989) has cylindrical to clavate obtusely rounded hairs.

The hairs of our fungus are somewhat similar to those described in the genus *Asperopilum* Spooner but the latter has J- asci and paraphyses branched in their upper part (Spooner, 1987).

Our fungus also bears resemblance to some species of *Mollisina* Höhn. sensu Huhtinen (1987) but it lacks the solid refracting projections in some hairs (particularly on the flanks of the apothecium).

So remains the last possibility to place this species in *Phialina* Höhn. sensu Huhtinen (1990). In fact, it fits the genus rather well in its hair and paraphyse shape, yellow oily content in hairs and paraphyses and remains deviant in the hair granulation which does not dissolve in KOH, Melzer's reagent or lactic acid.

Graddonidiscus Raitv. & Galán gen. nov.

Apothecia gregaria, primo subglobosa dein cupulata, minuta, sessilia, albida vel pallide colorata, extus e margine breviter pilosa. Excipulum ectale ex "textura angularis-prismatica" compositur, cellulis hyalinis vel pallide fumosis, tenuiter tunicatis. Pili cylindracei, cylindraceo-fusoidei vel lageniformes, hyalini vel subfumosi, tenuiter tunicati, aseptati vel raro 1-septati, breves, apice vel intertum in parte superiore crystalliferes. Asci clavati vel cylindraceo-clavati, poro iodo coerulescentia, biseriati. Sporae ellipsoideo-clavatae vel suballantoideae, hyalinae, aseptatae. Paraphyses cylindracei, apice subclavati, ascos non superantes.

Species foliicolae.

Typus generis: Dasyscyphus coruscatus Graddon, Trans. Brit. Mycol. Soc. 69: 260 (1977).

Apothecia gregarious, at first subsphaerical, then cup-shaped, small, sessile, whitish or pale coloured, externally and particularly at the margin covered by short hairs. Ectal excipulum composed of "textura angularis-prismatica". Individual cells hyaline to pale smoky-brown, thin-walled, angular, elongated angular to prismatical. Hairs cylindrical to fusiform-cylindrical or bottle-shaped, straight or sometimes slightly flexuous, never branched, hyaline, thin-walled, aseptate or very rarely 1-septate, smooth, bearing sphaerical crystal caps or encrusted on their upper part by irregular crystals. Asci arising from simple septa, clavate to cylindric-clavate, sometimes shortly stalked, with J+ apical pore, 8-spored with biseriate arrangement of spores. Ascospores clavate-ellipsoid, usually inequilateral and slightly curved to almost allantoid, hyaline, aseptate. Paraphyses cylindrical, branched at the base, sparsely septate, not or very slightly exceeding the asci, slender, apically subclavate.

Etymology: named in the honour of W.D. Graddon.

It is evident that the crystal caps on the hairs is not a sufficient character to place *D. coruscatus* Graddon in the genus *Dasyscyphus* (=*Lachnum* or its segregates). There has been. however, no particular need to erect a new genus for this peculiar species. Now when an another species congeneric with *D. coruscatus* is discovered the authors are forced to erect a new gwnus for two closely related foliicolous species which belong evidently to the subfamily Hyaloscyphoideae of the Hyaloscyphaceae (Raitviir, 1987). The structure of the excipulum and hairs of *Graddonidiscus* is typical for the members of this subfamily but it differs from all other genera of this subfamily in spherical conglomerations of crystals seated on the tips of the hairs. Its affinities may be toward *Incrupila* Raitv.

KEY TO THE KNOWN SPECIES

1. Ectal excipulum and hairs hyaline, ascospores 4-6x1.5-2 μm . . . . *G. coruscatus*

- Ectal excipulum and hairs pale smoky brown, ascospores 6.3-7.5x2-3 μm . . . . *G. hispanicus*

Graddonidiscus coruscatus (Graddon) Raitv. & Galán comb. nov. Basionymum: *Dasyscyphus coruscatus* Graddon, Trans. Brit. Mycol. Soc. 69: 260 (1977)

This species has been adequately described and illustrated by Graddon (1977). The differences between it and *G. hispanicus* are discussed under the latter species.

Graddonidiscus hispanicus Raitv. & Galán sp. nov. (Figs. 20-27).

Apothecia gregaria, primo subglobosa dein cupulata, ad 0.3 mm in diametro, sessilia, in vivo albida, in sicco sordide albida vel subgrisea, hymenio pallide ochraceo. Excipulum ectale ex "textura angularis-prismatica" compositur, cellulis pallide fumosis, tenuiter tunicatis, 8-10x5-6 μm. Pili lageniformes vel fusoideo-cylindracei, hyalini *vel subfumosi, tenuiter tunicati, aseptati vel raro 1-septati, 15-25x3-5 µm, apice vel intertum in parte superiore crystalliferes. Asci clavati vel cylindraceo-clavati, poro iodo coerulescentia, biseriati 27-33x5.0-6.5 µm. Sporae ellipsoideo-clavatae vel suballantoideae, hyalinae, aseptatae, 6.3-7.5x2.0-3.0 µm. Paraphyses cylindracei, apice subclavati, ascos non superantes, 1.5-2.5 µm in diametro.*

Ad folia sicca Quercus ilex subsp. ballota (=Q. rotundifolia) crescit

Graddonidiscus coruscatus (Graddon) Raitv. & Galán similis, sporis majoribus e cellulis excipularibus subfumosis differt.

Holotypus: ad folia sicca Quercus rotundifolia, Tamajon, Guadalajara, Spain, 25.10.1990, C. Ochoa, G. Moreno & M. Heykoop legerunt, in herbario R. Galán conservatur (RG-6595).

Apothecia gregarious, at first subsphaerical, then cup-shaped, up to 0.3 mm in diameter, sessile. Receptacle and disc whitish in fresh condition; receptacle grayish, disc pale ochraceous when dry. Margin and flanks (in minor degree) covered by short grayish-white hairs. Excipulum composed of "textura angularis-prismatica". Individual cells pale smoky-brown, thin-walled, angular to prismatical, 8-10x5-6 µm. Hairs bottle-shaped to fusiform-cylindrical, sometimes slightly flexuous, never branched, hyaline, thin-walled, aseptate or very rarely 1-septate, smooth, 15-25x3-5 µm, bearing sphaerical crystal caps or encrusted on their upper part by irregular crystals. Asci arising from simple septa, clavate to cylindric-clavate, sometimes shortly stalked, with J+ apical pore, 8-spored with biseriate arrangement of spores, 27-33x5.0-6.5 µm. Ascospores clavate-ellipsoid, usually inequilateral and slightly curved to almost allantoid, hyaline, aseptate, 6.3-7.5x2.0-3.0 µm. Paraphyses cylindrical, branched at the base, scarcely septate, not or very slightly exceeding the asci, apically subclavate, 1.5-2.5 µm in diameter.

On fallen decaying leaves of *Quercus ilex* subsp. *ballota* (=*Q. rotundifolia*)

Specimen examined: On dead leaves of *Quercus ilex* subsp. *ballota*, Tamajon, Guadalajara, Spain, 25.10.1990, coll. C. Ochoa, G. Moreno & M. Heykoop (Holotype in the herbarium of R. Galán No. 6595)

This species is closely related to *Graddonidiscus coruscatus* (Graddon) Raitv. & Galán but differs from it in several characters. Its ectal excipulum is pale smoky-brown whereas the ectal excipulum of *G. coruscatus* is always hyaline. Also it has larger spores and comparatively wider asci. Also the hairs of *G. coruscatus* are never so typically bottle-shaped as in *G. hispanicus*.

ACKNOWLEDGEMENTS

One of the authors, R. Galán, thanks the Education and Science Ministry of Spain for the financial assistance to the Research Project (PA 86-0063): "Estudio de los hongos que fructifican enel Parque Natural de Monfragüe, Cáceres, España". He thanks also Drs. F. Esteve-Raventós, G. Moreno (Alcalá de Henares University) and A. Ortega (Granada University) for their valuable collaboration. The authors are greatly indebted to Dr. Brian Spooner (Kew) for helpful discussions and suggestions and to Dr. Seppo Huhtinen (Turku) for useful critical remarks. The authors thank Mrs. Urve Martinson (Tartu) for linguistic help.

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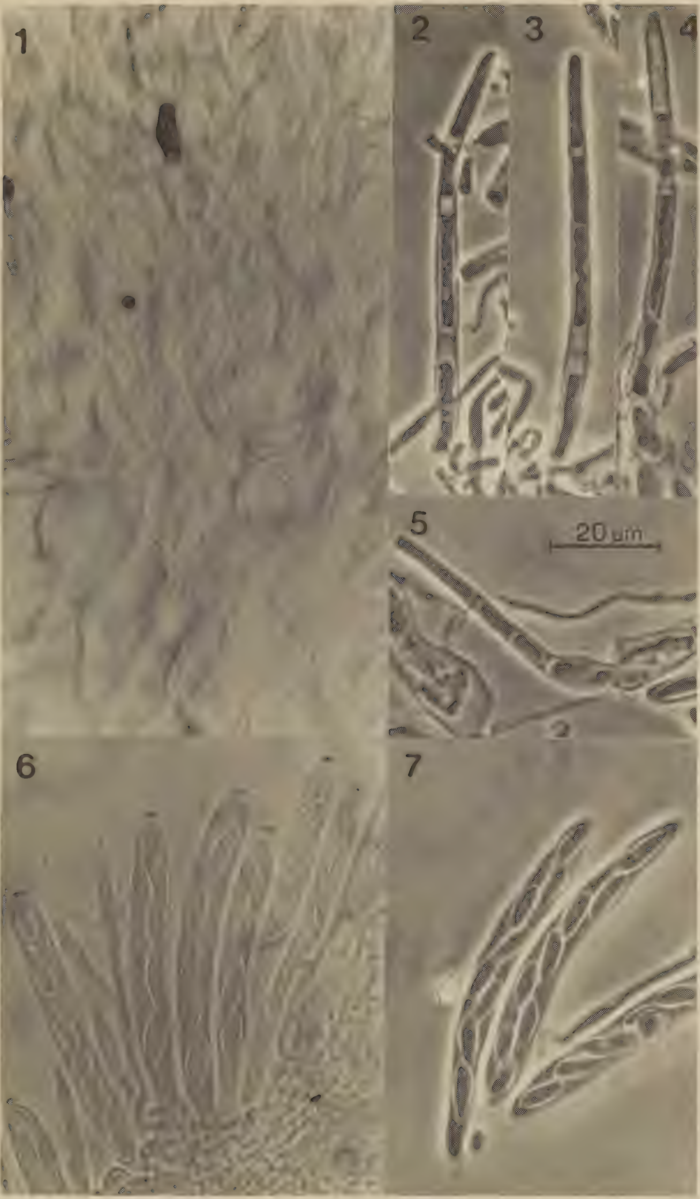
Figs. 1-11. *Lachnum trapeziforme*.
Fig. 1: Cells of the ectal excipulum; Figs. 2-7: Receptacular hairs; Figs 6-8: Asci containing spores and paraphyses; Fig. 9: Apothecia; Fig. 10: Margianl hairs; Fig. 11: Excipular cells.

Figs 12-19. *Phialina carpinacea.*
Fig. 12-13: Asci, paraphyses and spores; Fig. 14: Hairs (indicated by arrows) and excipular cells; Figs. 15-16: Flexuous hairs showing the granulate surface (arrows); Fig. 17: Asci, paraphyses and spores; Fig 18: Apothecia in different views; Fig. 19: Ectal excipulum and hairs.

Figs 20-27. *Graddonidiscus hispanicus*.
Figs. 20-21: Asci, paraphyses and spores; Figs. 23-24: Excipular cells and typically bottle-shaped (arrows) hairs with crystal caps; Fig. 25: spores; Fig. 26: Asci, paraphyses and spores; Fig. 27: Excipular cells and hairs.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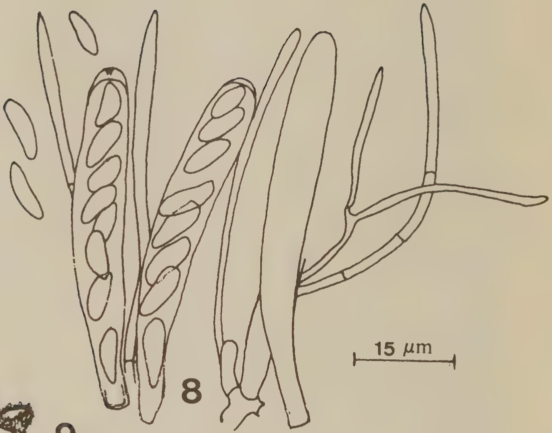

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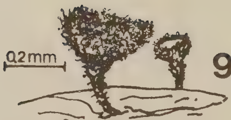

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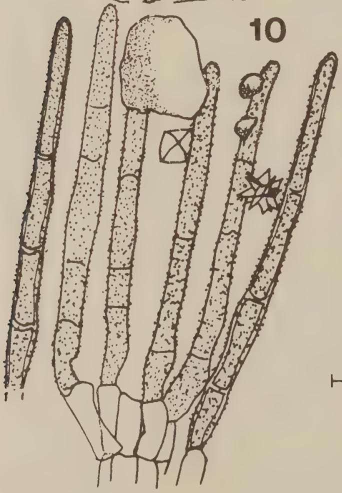

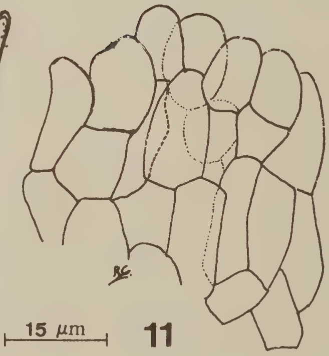

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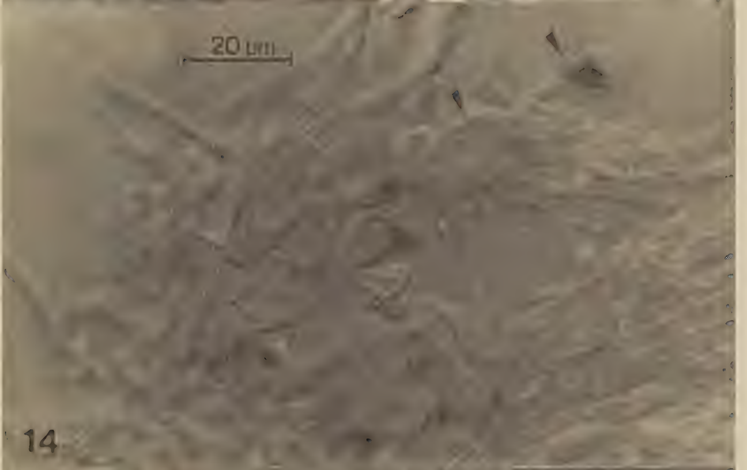

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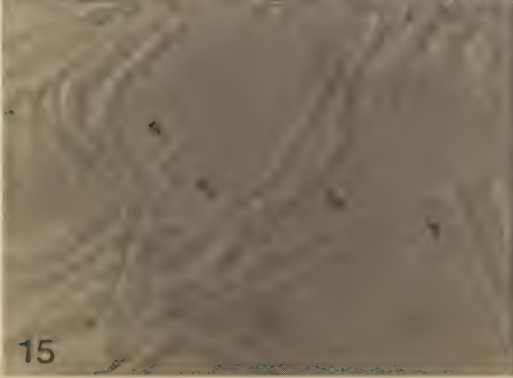
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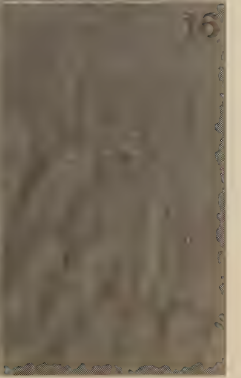
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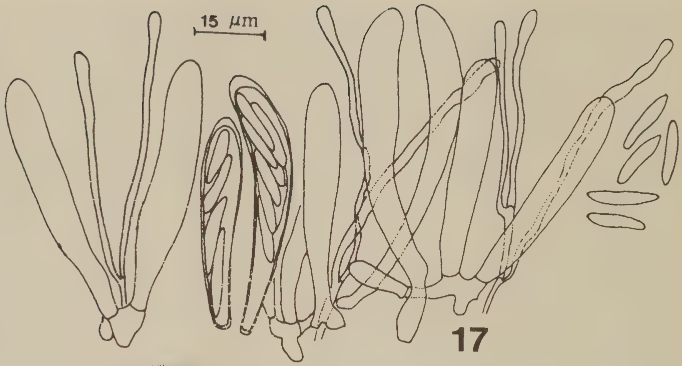

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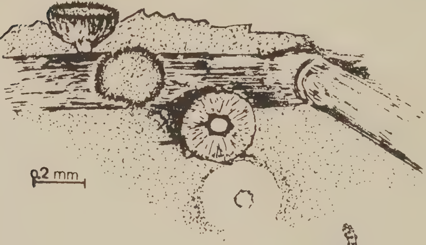

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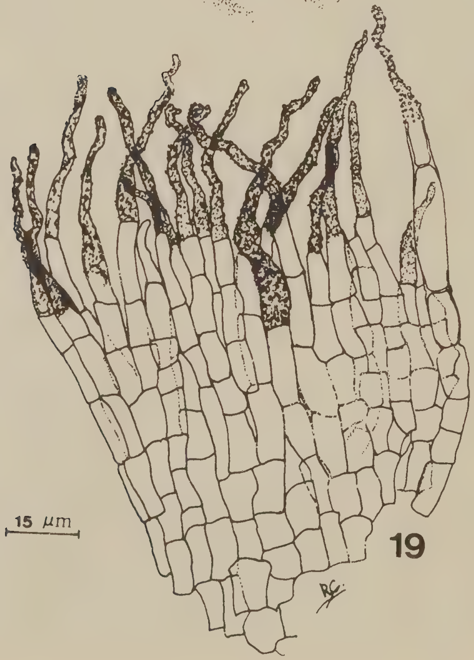

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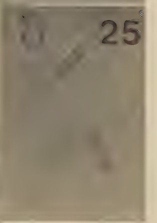
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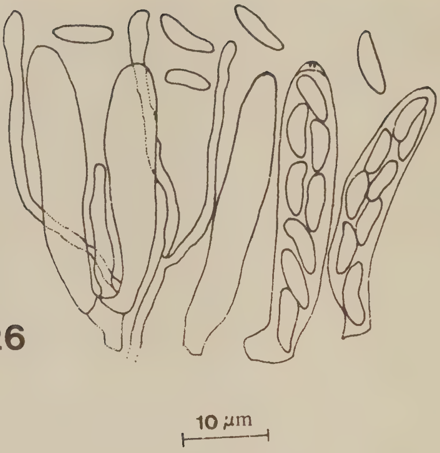

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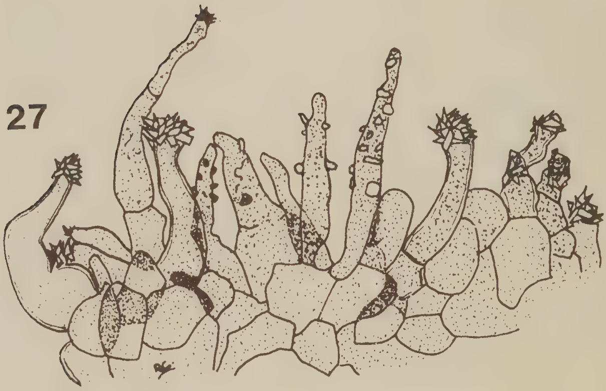

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MYCOTAXON

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ANZIA CENTRIFUGA, A NEW LICHEN SPECIES FROM PORTO SANTO, MADEIRA

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SUMMARY

The new species *Anzia centrifuga* Haugan is described from the island Porto Santo, NE of Madeira, in the Madeira archipelago. The species is saxicolous in sunexposed and dry habitat. The genus *Anzia* is reported for the first time from Macaronesia.

INTRODUCTION

The genus *Anzia* Stizenb. was described by Stizenberger (1861) as a tribute to the Italian lichenologist Martino Anzi. *Anzia*, and the related genus *Pannoparmelia* (Müll. Arg.) Darb., are characterized by the presence of a spongy, cushion-like tissue on the lower side of the lobes. This tissue, which was named spongiostratum by Hannemann (1973), consists of loosely anastomosing hyphae, and originates from the meristematic zone in the apical part of the lobes (Henssen & Dobelmann 1987). *Anzia* is further characterized by having numerous spores in the ascus, a feature which distinguishes it from *Pannoparmelia*, which is octosporous (Darbishire 1912).

Anzia was divided into three sections by Asahina (1935). Sect. *Nervosae* was characterized by the presence of a chondroid axis in the medulla, which is lacking in the two other sections. Sect. *Simplices* and sect. *Duplices* were delimited by having a single-layered and double-layered medulla, respectively. Yoshimura (1987) limited the two latter sections since he found intermediate forms. The members of sect. *Anzia* sensu Yoshimura occur only in eastern Asia and eastern North America, while those of sect. *Nervosae* sensu Yoshimura are distributed throughout the tropical and subtropical regions of both the new and the old world (Yoshimura & Sharp 1968, Galloway 1978, Yoshimura 1987). A new species of *Anzia* has recently been discovered in the Madeira archipelago, and is described below.

MATERIAL AND METHODS

Material of the new species was collected by R. Haugan, H. Krog and E. Timdal (deposited in O) and P. W. James (deposited in BM) during an excursion to Madeira in April 1988. Specimens of related species (partly borrowed from UPS) were examined for comparison.

Sections for microscope studies were cut on a freezing microtome and mounted in H_2O, 10% KOH, 25% H_2SO_4, and acetone. A polarization filter was used to locate crystals of lichen substances and calcium oxalate. Thin-layer chromatography was performed in accordance with standard methods (Culberson & Kristinsson 1970, Culberson 1972). Calcium oxalate was identified by mounting a microscope preparation in 25% H_2SO_4, in which the oxalate crystals dissolve and recrystallize by forming needle-shaped crystals. Some microtome sections were washed in acetone in order to dissolve crystals of lichen acids before they were mounted in water or KOH. This proved the presence or absence of crystals which are not dissolved in acetone. Spores were measured in a microscope at 40× and 100× magnifications. Twentyfive spores were measured from four specimens. Spore measurements are given in the form $(x_L-1.5*\sigma_{n-1})-(x_L+1.5*\sigma_{n-1}) \times (x_B-1.5*\sigma_{n-1})-(x_B+1.5*\sigma_{n-1})$, rounded to the nearest 1 µm, where x_L and x_B are the arithmetic mean of spore length and breadth respectively, σ_{n-1} is the corresponding standard deviation, and * is the multiplication operator. Scanning electron microscopy (SEM) and a photomicroscope were used for photographs of cross-sections of the thallus. A stereo photomacroscope was used for habitus photographs.

RESULTS

Anzia centrifuga Haugan, sp. nov.

Thallus saxicolus, ad 30 cm diam., pallide griseus, orbicularis, sine sorediis et isidiis, in centrum emoriens. Laciniae 1–2 mm latae, crebro dichotome ramosae, imbricatae, rugosae, lobis obtusis pruinosis, leviter maculatis. Axis chondroideus depressus, interruptus. Rhizinae atrae, paucae. Spongiostratum continuum, atrum. Apothecia numerosa, ad 10 mm diam., pedicellata, cupulata, discis scabrosis, badiis vel atris. Hymenium ad 125 µm altum, incoloratum, epithecio olivaceo. Asci sporis numerosis; sporae 9–15 × 2–4 µm. Spermogonia ignota. Acidum divaricaticum, atranorinum et substantiae terpenoideae continens.

Type: Portugal, Madeira archipelago, Porto Santo, Pico do Castelo, 33°05'N, 16°20'W, 350 m alt., on sun-exposed rock, 7 April 1988, R. Haugan et al. 6126 (O, holotype; BM and UPS, isotypes).

Thallus saxicolous, adnate to loosely attached, orbicular, forming large rosettes up to c. 30 cm diam., pale grey, turning darker in older parts, without isidia and soredia; old specimens dying towards the center of the thallus. *Lobes* 1–2 mm wide, richly dichotomously branched, imbricate, broader and rounded towards the tips; older parts rugose, convex, richly pitted, with apothecial initials in the pits, smooth and flat towards the tips; lobe tips pruinose (calcium oxalate), faintly maculate. *Medulla* with a chondroid axis which is more or less discontinuous, being better developed above the rhizines than inbetween. *Lower side* with a continuous spongiostratum (frequently grazed by arthropods or snails, and therefore scattered towards the center), hardly visible from above, with a corticate outer surface when young. *Rhizines* developing from the chondroid axis, stout, black, sometimes weakly branched near the apex, rather scattered.

Apothecia common, to c. 10 mm diam., pedicellate, cupuliform; disc scabrous, somewhat shining when young, red-brown to black; margin entire, thin, crenate when old; the thalline exciple finely tomentose, white to yellowish. *Hymenium* up to 125 µm deep, colorless, with an olivaceous brown pigment in the epithecium. *Asci* with numerous, crescent-shaped spores, 9–15 × 2–4 µm. *Spermogonia* not seen.

Chemistry: Atranorin, divaricatic acid and several unknown terpenoids present; upper cortex K+ yellow (atranorin), C–, PD–, with crystals of unknown substance which are insoluble in acetone but soluble in KOH; medulla K–, C–, PD–, packed with crystals

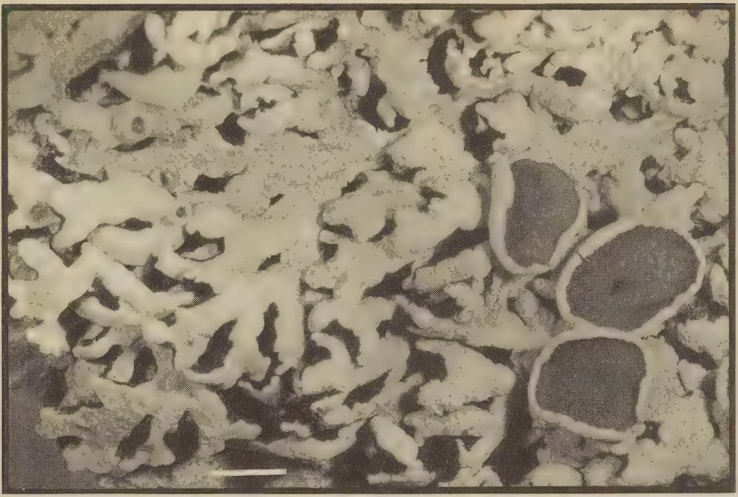

Fig. 1. *Anzia centrifuga*, habit. Holotype. Rule 2 mm.

which extend into the rhizines (soluble in acetone and KOH); medulla outside the chondriod axis containing crystals of divaricatic acid (soluble in acetone and KOH); the transition zone between medulla and spongiostratum with crystals of calcium oxalate which are masked by other substances unless the section is treated with KOH; the inner zone of the spongiostratum (near the medulla) contains crystals (soluble in acetone and KOH); the thalline exciple of the apothecia K+ yellow, with an outer zone characterized by the same crystals as in the upper cortex, and an inner zone with crystals similar to those in the medulla; crystals of calcium oxalate are extending from the medulla into the pedicels of the apothecia.

Distribution and ecology. The new species is known only from two localities on the volcanic neck Pico do Castelo on the island Porto Santo in the Madeira archipelago. The species grew on bare rock in a dry, sunexposed habitat, and was associated with e.g. *Heterodermia leucomelos* (L.) Poelt and *Ramalina* spp.

Additional specimen examined: Portugal: Madeira archipelago, Porto Santo, Pico do Castelo. 33°05'N, 16°20'W, alt. 430 m, on sun-exposed rock near the summit, 7 April 1988, R. Haugan et al. 6176.

DISCUSSION

The presence of a chondroid axis in *Anzia centrifuga* indicates inclusion in sect. *Nervosae*. The morphologically most similar species of this section is *A. parasitica* (Fée) Zahlbr, which is recorded from tropical America and Madagascar (des Abbayes 1956; Yoshimura 1987). This species has more slender lobes, the chondroid axis is more distinct than that of *A. centrifuga*, and the thallus is not dying towards the center. It contains divaricatic acid and atranorin, but differs from *A. centrifuga* in the terpenoid

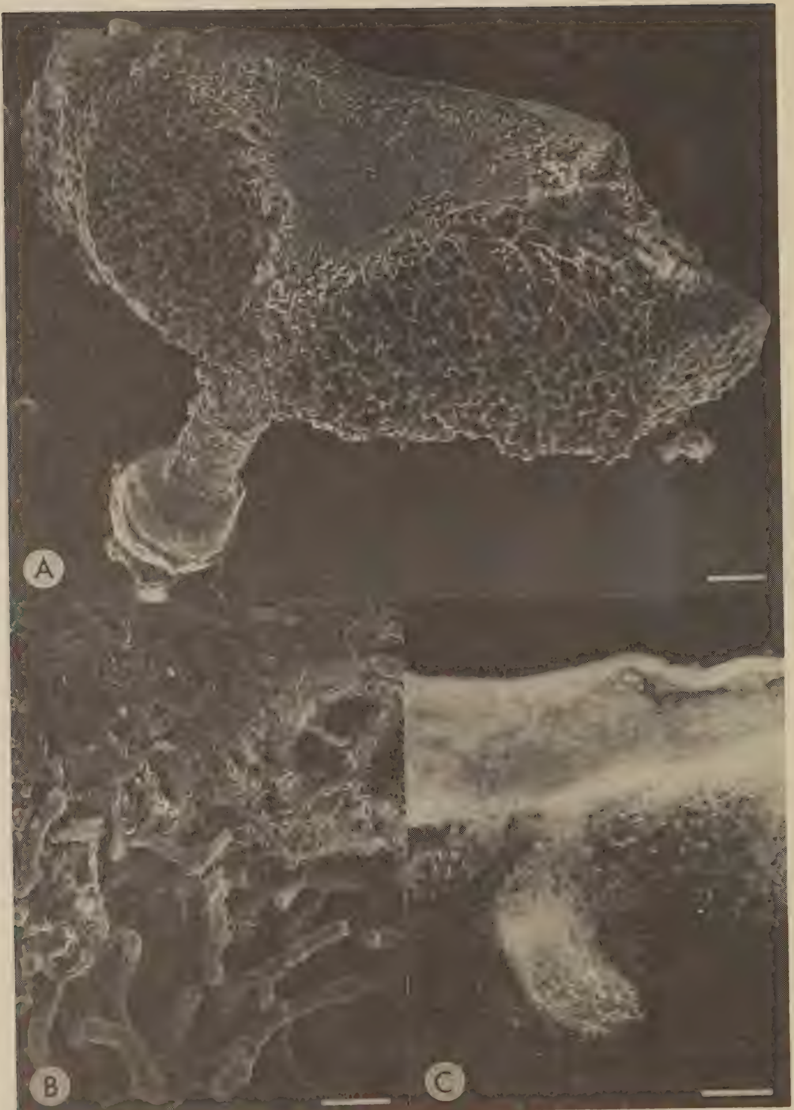

Fig.2. *Anzia centrifuga*: cross-sections of thallus. – **A**. SEM photograph showing the chondroid axis, spongiostratum and a rhizine; rule 100 µm. – **B**. SEM photograph showing the transition zone between medulla and the spongiostratum; rule 10 µm. – **C**. Photomicroscope photograph showing crystals in upper cortex, medulla and a rhizine; rule 100 µm.

pattern. It also differs ecologically in being a corticolous rainforest species.

There are several species of sect. *Nervosae* in SE Asia (Yoshimura 1987). None of these species seem to be similar to *A. centrifuga*, and they all differs morphologically, chemically and ecologically from the new species.

As mentioned above, the three sections of *Anzia* proposed by Asahina (1935) were reduced to two by Yoshimura (1987). According to Yoshimura (1987) sect. *Nervosae* is well delimited by the presence of a chondroid axis (which is convergent with the central axis in *Usnea*), while sect. *Anzia* lacks this structure. In *A. centrifuga*, the axis is discontinuous, and the species apparently occupies an intermediate position between the two sections. As in most species of sect. *Nervosae*, it has a continuous spongiostratum.

Anzia centrifuga has a most specialized ecology; it is the only known species of the genus growing on dry and sunexposed rock. Together with six *Ramalina* species which have been described from Porto Santo (Krog & Østhagen 1980; Krog 1990), it is apparently a representative of the unique endemic flora element on the volcanic necks of this island.

The genus is not previously reported from Macaronesia. The nearest region where the genus is represented, is in the East African montane rain forest, where the sorediate species *A. afromontana* R. Sant occurs. (Swinscow & Krog 1988).

ACKNOWLEDGEMENTS

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MYCOTAXON

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A UNDESCRIBED SPECIES OF OXYPORUS (POLYPORACEAE) FROM CHINA

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SUMMARY

A new species of the genus Oxyporus collected from Jilin Province (China) is described as Oxyporus sinensis Zeng sp. nov.. This species can easily be separated from O.populinus (Fr.) Donk by its thin tube layers, large pores and slightly large spores. O.nobilissimus Cooke is different from this species by its large basidiocarps and deep surface layer of interwoven fibers. We can also distinguish this species from O.phellodendri Bond.& Vass. by its more regular round pores and more perennial basidiocarps.

While studying the specimens of the Polyporaceae deposited in the Herbarium of Botany at the Biology Department of Northeast Normal University, the author noticed a species that named as Rigidoporus ulmarius (Sow.:Fr.) Imazki. However, it has lightcolored basidiocarps, and carefully examining showed that it had numerous cystidia with thick wall and capitate incrustation in hymenium. Obviously, the species should belong to the genus Oxyporus. In this paper, it is described as new.

Microscopic characters were determined from freehand sections and squash mounts in 5 percent KOH. Scanning electron microscopy was also used for the determing of cystidia and spores.

Oxyporus sinensis Zeng, sp. nov. Fig. 1,2
Sporophorum perenne, sessile vel resupinato-reflexum, singulare vel imbricatum,suberoso-lignosum,10 x 10 x 2 cm, in basi usque ad 4 cm crassum. Pileus canus vel

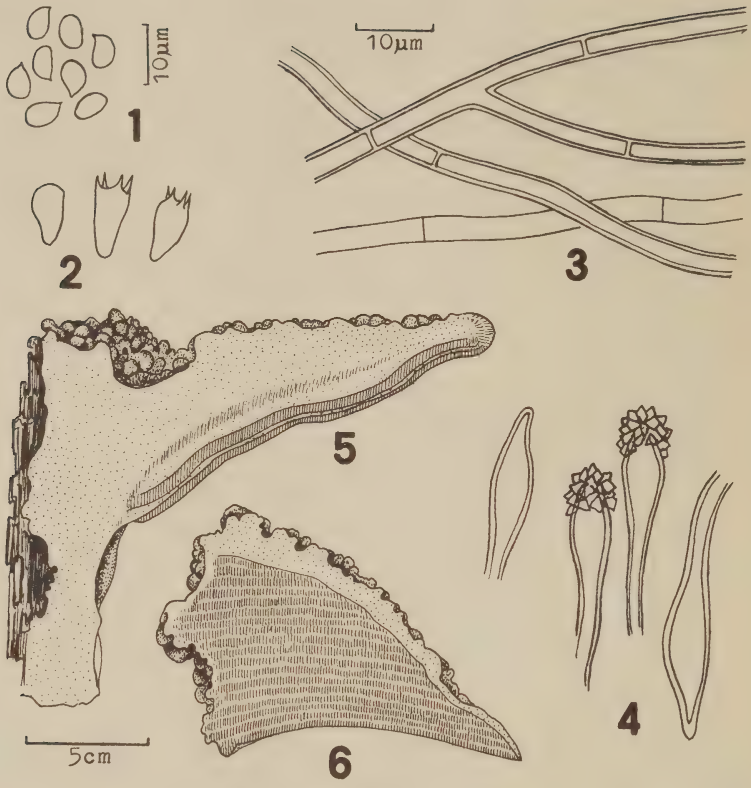

Fig.1 Oxyporus sinensis: 1.spores 2.basidia 3.hyphae 4.cystidia 5.basidiocarp O.populinus: 6.basidiocarp

flavo-albus, prope basin algis obtectis, superficie irregularibus verruculis, margine obtuso,sterili. Pori majores, orbiculares vel suborbiculares, 3-4 per mm, superficie flavo-umbrinis, dissepimentis tenuibus; tubuli stratosi, 2-5 strata, per stratum 0.2-0.5 cm crassum, inter strata contextibus pallidis. Contextus cremeus, suberosus, 1-3 cm crassus.

Systema hypharum monomiticum, hyphae septatae, ramis paucis,hyphae contextorum hyalinae, membranis crassioribus,hyphae tramarum hyalinae, membranis tenuioribus, 2-4 µm diam.. Cystidia numerosa, 15-28 x 4.5-6 µm, cylindrata vel clavata,membranis crassioribus, ad api-

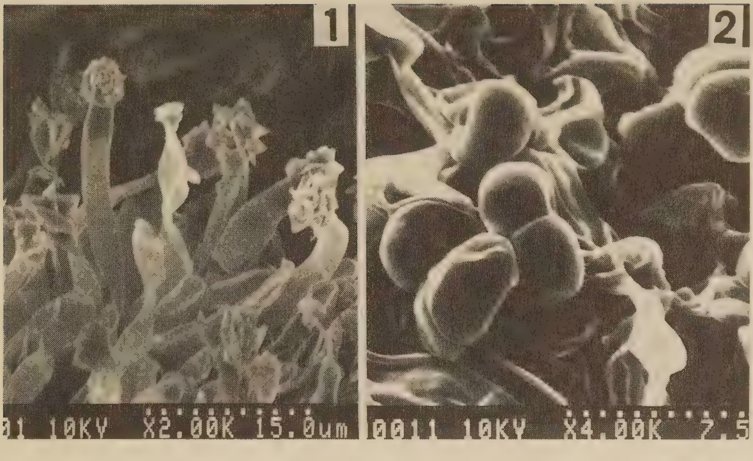

Fig.2 Oxyporus sinensis 1.cystidia 2.spores

ces crystallis, 5-10 µm diam.. Basidia clavata, 7-10 x 4-5 µm. Sporae subglobosae vel ellipsoidae, hyalinae, rasiles. 5-6(7) x 4-5 µm.
Ad bases arborum frondosarum.
Holotypus: Mt.Changbaishan, Aug.10,1980, Li. No.1324, in HBNNU conservantur,Changchun,China, isotype in O.

Sporophores perennial, sessile or effused-reflexed, single or sometimes imbricate and laterally fused, corky to woody, 10 x 10 x 2 cm, up to 4 cm thick at the base. Pileus buff or greyish, offen darkening with age and covered with algae at the base; surface scabrous,offen covered with irregular warts:margin obtuse, sterile.Pore surface buff to brownish,the pores large, circular to subcircular, 3-4 per mm, with thin dissepiments: tubes concolorous or slightly darker than the context, distinctly stratified, 2-5 strata, separated by a thin layer of context tissue, 0.5-1 cm deep. Context cream colored, cooky, azonate, up to 3 cm.
Hyphal system monomitic; contextual hyphae hyaline, simple-septate, slightly thick-walled,rarely branched, 2-4 µm in diam; tramal hyphae similar, mostly thin-walled. Cystidia abundant, thick-walled, cylindric to clavate, rarely bottle shaped, 15-28 x 4-6 µm, capitately incrusted,incrustation dissolving rapidly in KOH, incrusted portion 5-10 µm in diam. Basidia short clavate, 7-10 x 4-5 µm. Basidiospores ellipsoid to

subglobose. hyaline, smooth, 5-6(7) x 4-5 µm.
Type of rot: White rot of living and dead hardwoods.
Specimens examined: Jilin Prov., Dunhua Xian, Sep.12, 1985, Zeng No.0053; Jiaohe Xian, Aug.6,1987, Zeng No. 0968; Mt.Changbaishan, Aug.10,1980, Li No.1324(Holotype)deposited in HBNNU, Changchun, China.
Remarks: The species is well differentiated from the other species in the genus by its perennial, sessile basidiocarp with the tube layers separated by layers of context. The only three species in the genus with these characters are O.populinus, O.nobilissimus and O.phellodendri, but O.populinus has conchate pileus, thick tube layers, small pores, 6-8 per mm, slightly small spores, O.nobilissimus has enormous basidiocarps on conifers and deep surface layer of interwoven fibers and O.phellodendri has more regular round pores and more perennial basidiocarps.

ACKNOWLEDGEMENTS

I extend my sincere thanks to Dr. L.Ryvarden for his further examination of the species and critical review of the manuscrip. Prof.Zhao Yi-Tong of the Biology Department of Northeast Normal University, Changchun is sincerely thanked for his help in my Latin descriptions.

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JUNGHUHNIA CONCHIFORMIS NOV.SP. (POLYPORACEAE,BASIDIOMYCETES)

by

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SUMMARY

A species of Polyporaceae collected from Jilin Province is reported as new in this paper. The main character of this species is that it combines a spherical incrustation at the top of cystidium in hymenium with dimitic hyphal system. Obviously, it should belong to the genus Junghuhnia. However, this species is different from the known species of Junghuhnia. The name J.conchiformis sp.nov. is proposed, and Latin descriptions,illustrations as well as the picturs of scanning electron microscopy are also given for the species.

Junghuhnia conchiformis Zeng & Ryv. sp. nov. Fig. 1,2
Sporophorum annuum, sessile vel resupinato-reflexed, conchiforme, saepe imbricatum, suberoso-lignosum,0.2 x 1 x 2 cm. Pileus dimidiatus, primo canus vel flavo-albus, denso velveto, postea fuscans superficie alga obtecto. Pori regulares vel irregulares, inaeguales, 7-9 per mm,sepimentis tenuibus,superficie flavo-albus. Strata tubulorum flavida, 0.1-0.2 cm crassa, 1 stratum vel 2 strata. Contextus tenui, flavo-albus, 0.1 cm crassus.

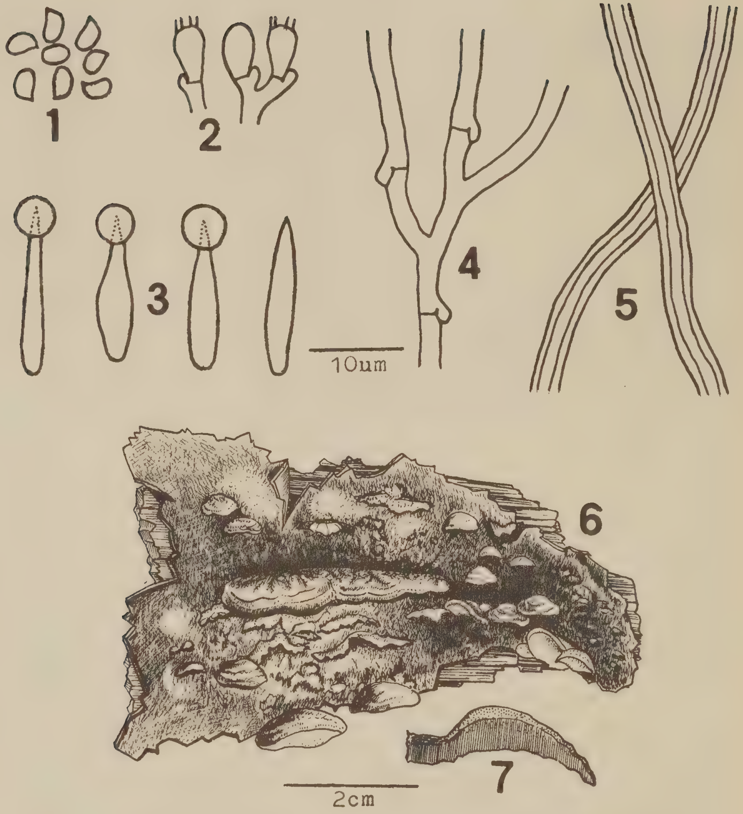

Fig.1 Junghuhnia conchiformis 1. spores 2.basidia 3.cystidia 4.generative hyphae 5.skeletal hyphae 6.basidiocarps 7. longitudinal section of basidiocarp

Systema hypharum dimiticum; hyphae generatoriae hyalinae, membrana tenui, fibulatae, 2-3 µm diam., ramis numerosis: hyphae skeletales hyalinae, numerosae, membrana crassa,non ramis,2-3 µm diam.. Cystidia conoidea vel teretia, membrana tenui, 2-4 x 15-20 µm, 10-15 µm ultra hymenia, crystallo major sphaerico ad extrema cystidiorum;sphaericae crustae 3-6 µm diam.,sublaeves, evanidae in KOH. Basidia minor, clavata, 2-4 x 3-6 µm. Sporae minor,ovoidae vel oblongae, hyalinae. 2.5-3.5 x 2-2.5 µm.

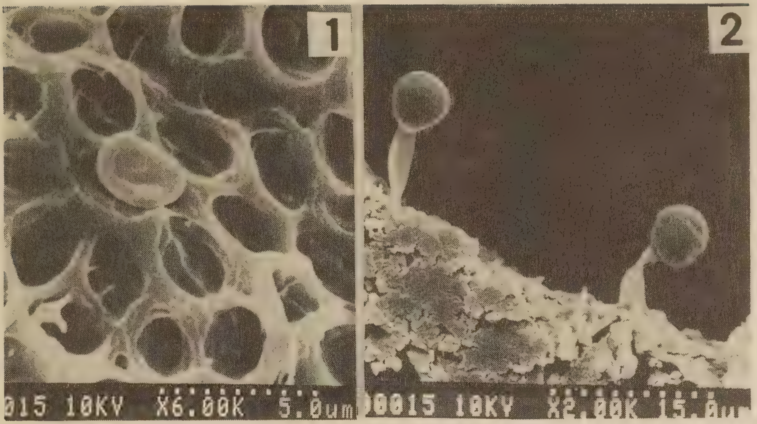

Fig.2 J. conchiformis 1.spores 2.cystidia
(scanning electron microscopy photographs)

Ad corticem Abies nephrolepsis.
Holotypus: Jilin Prov., Mt.Changbaishan, Aug.16, 1988, Zeng No.1654 in HBNNU conservantur, Changchun, China. isotype in O.

Fruitbody annual, sessile or resupinate-reflexed, rarely resupinate, conchate, often laterally fused and imbricate with many narrow pilei, corky to woody, 0.2 x 1 x 2 cm. Pileus dimidiate, at first canous or creamy white, velutinous, later darkened and often covered with algae. Pores regular or irregular, diameter variable, 7-9 per mm, sepiments of pores thin, pore surface cream to straw coloured, margin incurved. tubes cream to canous, 0.1-0.2 cm deep, 1 or 2 layers. Context thin, 0.1 cm deep, concolorous with tubes, corky to woody.

Hyphal system dimitic: generative hyphae thin walled, hyaline, clamps at the septa, frequently branched, 2-3 µm in diameter: skeletal hyphae numerous, hyaline, thick walled, unbranched, 2-3 µm in diameter. Cystidia conoid or cylindric, hyaline, thin walled, 2-4 x 15-20 µm, projecting the hymenium 10-15 µm, with a spherical incrustation at the top of cystidium, spherical incrustation 3-6 µm diameter, smooth, not dissolved in HCI solution but easily disappeared in KOH if you knock the cover glass slightly. Basidia minor, clavate, 2-4 x 3-6 µm. Spores minor, ovoide or oblong-ellipsoid, hyaline, 2.5-3.5 x 2-2.5 µm, smooth, thin walled.

On the bark of *Abies nephrolepsis*.
Dist. Jilin Prov., Mt.Changbaishan, Aug.16, 1988, Zeng No. 1654(Holotype)deposited in HBNNU,Changchun,China.
Remarks: The diagnostic characters of *J.conchiformis* are the often conchate and imbricate fruitbodies, the conoid or cylindric thin-walled cystidia with a spherical incrustation at the top and the ovoide or oblong -ellipsoid spores. Most *Junghuhnia* species are resupinate and have thick-walled, heavily incrusted skeletocystidia. They are obviously different from this species. In some respects, *J.conchiformis* is similar to the some species of *Antrodiella*,However,the species of *Antrodiella* has no incrusted cystidia in the hymenium. *Oxyporus* has cystidia which can vary from strongly encrusted to more smooth ones, but its monomitic hyphal system is different from the species of *Junghuhnia*.

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The first author (Z) wish to express his sincere thanks to Prof. Zao Yi-Tong of the Biology Department of Northeast Normal University for his help in Latin descriptions.

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TAXONOMIC REVISION OF THE GENUS CHEILYMENIA - 4. THE SECTION PARACHEILYMENIAE.

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ABSTRACT

Three species of the genus *Cheilymenia* Boud. emend. J.Mor. belonging to the section *Paracheilymeniae* J.Moravec (1990) are introduced, based on the examination of type and other relevant material. Besides *Cheilymenia pulcherrima* (Cr.et Cr.) Boud. and *Cheilymenia aurantiacorubra* Thind et Kaushal, a new species, *Cheilymenia lundqvistii* spec. nov. from Macaronesia is described and illustrated. The description of this new taxon is based on the author's examination of a collection, which was published recently under " *Cheilymenia* sp. 2573" by Korf & Zhuang (1991).
Notes of several other species reported from Macaronesia are also given. *Cheilymenia theleboloides* (Alb.et Schw.) Boud. var. *microspora* Dennis in Dennis, Reid et Spooner (1977) is a nomen dubium. *Cheilymenia cornubiensis* (Berk.et Br.) Le Gal is excluded from the genus and the new combinations, *Melastiza cornubiensis* (Berk.et Br.) comb. nov. and *Cheilymenia campestris* (Cr.et Cr.) comb. nov. are proposed. *C. campestris* is a member of section *Villosae* J.Mor.

INTRODUCTION

The section *Paracheilymeniae* J.Mor. was erected for two species of the genus *Cheilymenia* Boud. emend. J.Moravec (1990), *C. pulcherrima* (Cr.et Cr.) Boud. and *C. aurantiacorubra* Thind et Kaushal.
By the kindness of Prof. Dr. Richard P. Korf (Ithaca), I had an oportunity to examine several collections of *Cheilymenia* previously published by Korf & Zhuang (1991) from Macaronesia. One of these, from CUP-MM herbarium, previously reported under the name "*Cheilymenia* sp. 2573" proves to be a new species which also belongs to the section *Paracheilymeniae*. It is described below as a new taxon, *Cheilymenia lundqvistii* J.Mor. spec. nov.

TAXONOMIC RESULTS AND DESCRIPTIONS

Reexamination of several species reported from Macaronesia revealed that the collection described by Korf & Zhuang (1991) as"*Cheilymenia* sp. 2771" is *C. aurantiacorubra*. The same species is also CUP-MM 2773, deposited temporarily within packet for CUP-MM 2559. It is a mixed collection derived from UPS 8212-a from which CUP-MM 2559 and CUP-MM 2773 were taken. Two other collections reported as members of *Cheilymenia* are here excluded from the genus.

The collection described as "Cheilymenia sp. 2557" (On goat dung in moist chamber, Madiera, Ribeira de Taborada, W. of casa des Queimadas, alt 950 m, 28.I.1969 leg. Leif Tibell - CUP-MM 2557 ex UPS 3629-a, a mixed collection) has been redetermined as Mycoarctium ciliatum Jain et Cain. The description of"Cheilymenia sp. 2557" given by Korf & Zhuang (1991 p.90) shows typical features of the peculiar monotypic genus Mycoarctium, especially very thin filiform paraphyses which are not enlarged above, and hairs possessing rather thick walls. I have found that the apothecia of this collection were mostly immature. This may explain why the collection was considered to be a species of Cheilymenia by the authors. However, I have found several apothecia possessing mature ascospores with a typical reticulate ornamentation and, as well as numerous straight hairs, hairs with hooked tips are also present. Furthermore, the apothecial anatomy of this collection essentially differs from Cheilymenia. All these features well agree with these of Mycoarctium ciliatum as described by Jain & Cain (1973). This taxon was also reported by Korf & Zhuang from Tenerife. Another taxon reported from Macaronesia is Cheilymenia theleboloides (Alb.et Schw.) Boud. var. microspora Dennis in Dennis, Reid et Spooner (1977), also included to the discomycete flora of Macaronesia by Korf & Zhuang (1991). However, the type collection (K) contains apothecia of several discomycetes on the substrate (cow dung). It is evident that the original diagnosis was based partly on apothecia of Cheilymenia granulata (Bull.) J.Mor., and that the thin-walled superficial hairs illustrated by Dennis were admixed from apothecia of Cheilymenia raripila (Phill.) Dennis growing densely clustered with the apothecia of the former. Other discomycetes which I have found on the same collection are Cheilymenia insignis (Cr.et Cr.) Boud., Saccobolus sp., Coprotus sp. and others. Consequently, I have no doubt that C. theleboloides var. microspora is a nomen dubium.

The two taxa of Cheilymenia determined from the Macaronesian collections and mentioned above are members of the section Paracheilymeniae and complete the section, which is typified by C. pulcherrima. The descriptions of the three species follow:

Cheilymenia Boud. emend J.Moravec, Mycotaxon 38:473, 1990.
sect. **Paracheilymeniae** J.Moravec, Mycotaxon 38:475, 1990:

Type species:
Cheilymenia pulcherrima (Cr.et Cr.) Boud.

Ascobolus pulcherrimus Crouan et Crouan, Ann, Sci. Nat. (Bot.) IV, 10:196, 1858.
Peziza pulcherrima (Cr.et Cr.) Cooke, Mycogr. 84, 1876.
Humaria pulcherrima (Cr.et Cr.) Spegazzini, Michelia 1:37, 1878.
Lachnea pulcherrima (Cr.et Cr.) Gillet, Champ. Fr. 76, 1880.
Scutellinia pulcherrima (Cr.et Cr.) O.Kuntze, Rev. Gen. Pl. 2:869, 1891.
Lasiobolus pulcherrimus (Cr.et Cr.) Schroeter, Krypt.- Fl. Schles. (ed. Cohn) 3 (2):54, 1893.

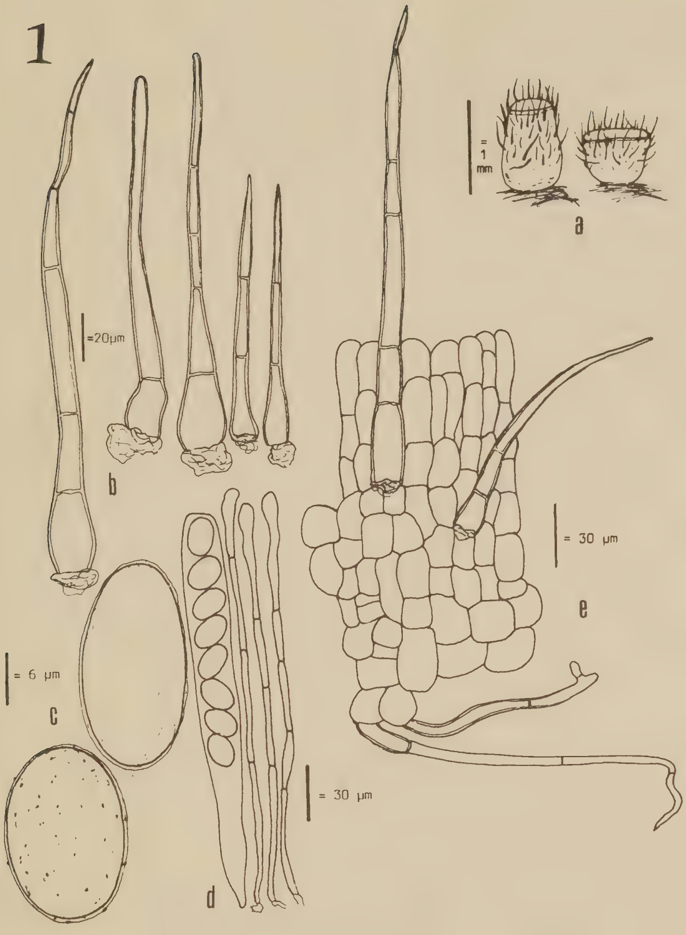

1
= 1 mm
a
=20µm
b
= 30 µm
e
= 6 µm
c
= 30 µm
d

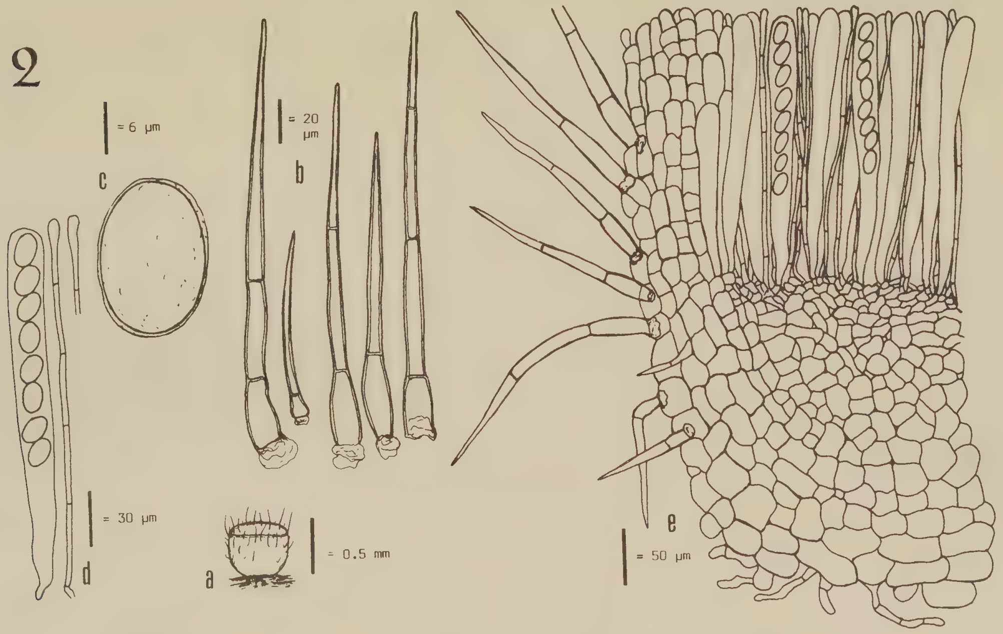
Fig. 1. Cheilymenia pulcherrima: **a**. Apothecia; **b**. Hairs; **c**. Ascospores under oil immersion + CB; **d**. Ascus and paraphyses, **e**. Texture of excipulum seen from outside (Isotype PC).

Patella pulcherrima (Cr.et Cr.) Seaver, N. Am. Cup-fungi (Operc.) 172, 1928.
Cheilymenia pulcherrima (Cr.et Cr.) Boudier, Hist. Class. Discom. Europ. 63, 1907.
Apothecia 0.3-0.6(-1) mm diam. and 0.4-1.2 mm high, scattered or clustered together, sessile, turbinate, subcylindric to barrel-shaped with discoid and flattened, bright orange-yellow hymenium; external surface yellowish-orange, densely or sparsely covered with pale brown hairs; the margin slightly raised, smooth, forming an inconspicuous collar. **Hairs** 80-220(-280) x 9-22.5 µm, superficial, usually swollen at the base and arising from cells of the ectal excipulum (the cells under the bases of hairs are usually abortive), straight or slightly curved, 1-3(-7) septate, thin-walled (the walls 0.6-1.5(-1.7) µm thick), pointed or blunt above, yellowish-brown. Hairs of the lower surface of the excipulum hyphoid and intermixed with hyaline septate hyphae. **Ectal excipulum** of textura globulosa angularis, composed of subglobose to ellipsoid cells, (8-)25-38 µm diam. , becoming smaller and vertically arranged towards the margin of apothecia and elongated to clavate at the margin, 15-28 µm wide. **Medullary excipulum** inconspicuously differentiated, composed of smaller, angular cells, which are 8-25 µm diam. and only occasionally elongated to irregular,short, 4-8 µm wide hyphae. **Hypothecium** not clearly differentiated, thin,composed of small, irregularly shaped cells and hyphae. **Asci** 150-180(-210) x 18-21.5 µm, eight-spored, broadly cylindric, with apex obtuse or truncate , the base shortly attenuated, simple. **Ascospores** uniseriate, ellipsoid, (17-) 18-25.5(-27) x (10-)12-14.5(-15) µm with yellow refractive contents; perisporium (the outermost delicate layer) easily and soon separated from the ascospores in lactic acid (often even whilst the ascospores are still in the asci), smooth, or with only irregular secondary wrinkling or occasionally covered by very small cyanophilic pustules (under oil immersion + CB and SEM). **Paraphyses** cylindric, 4-5 µm thick, straight, with apex enlarged to 6-9 µm, septate, with yellow granular contents.
Habitat: on dung.
Specimens examined;
1. France: Finistère, Environs de Brest, Croit par peuplades sur les bouses de vache anciennes, s. date, leg. Crouan (CONC-A 2388, type of Ascobolus pulcherrimus - a slide sent from UPS); **2**. A 2355 - isotype of the same locality (PC); **3**. Finistére, in fimo vaccino, février leg. Crouan (CONC A 2397, probably the paratype - a slide sent from UPS).
4. Germany: NSG Hüttelmoor bei Rostock, auf Pferdemist, 17.VIII, 1984, leg. J. Duty, det. D. Benkert (BHU);
5. Italy: Mendola prés de Bolzano (Bozen), Août 1889, leg. Bresadola (PC ex herb. Bresadola, ut Lachnea pulcherrima);
6 Sweden, Upland, Bondkyrka parish, S. Norby (near Upsala), 26.VIII.1927,leg. J.A.Nannfeldt (409)-1368 Lachnea pulcherrima (Fungi exs. Suecici Lundell et Nannfeldt, UPS,PC).
C. pulcherrima is the type species of the section Paracheilymeniae. It differs from other species of Cheilymenia in having extremely small, turbinate to barrel-shaped apothecia resembling these of Lasiobolus with a simple anatomy,

by the nearly smooth ascospore perisporium (only rarely covered by fine pustules) and the straight, superficial hairs, which are elongate-bulbous or conical at the base. It has been recently studied by Brummelen (1986). There are several differences in the description given above. I have found that the hairs are also more than 3 septate, and their walls are only up to 1.7 µm thick. Also, I have not found aseptate hairs in apothecia of the type and other material. Brummelen has given the hair walls as up to 2.5 µm thick in this species and also aseptate hairs. These differences might be caused by the fact that there are hairs of a *Lasiobolus* sp. admixed in the slides taken from the type collection that I have also seen. Furthermore, I have found that the perisporium is easily separable from the ascospores in CB, and usually early in development, just before the ascospores are released from the asci. Another difference is that I have found that the apothecia do not exceed 1 mm diam. only, whilst Brummelen (1986) has given the size as up to 2 mm. I think we must be careful here as there are several other discomycetes on the substrate of the type and other collections too. The colour of apothecia was originally given as yellow-orange. However, in one collection reported above (Benkert), the apothecia are blackish-grey when dried and greyish-yellow when revived. This unusual colour might be caused by a different preservation or drying. Brummelen (1986) suggests placeing *C. pulcherrima* close to *Cheilymenia insignis* (Cr.et Cr.) Boud..I have examined the type (a slide sent from UPS ex CONC) of *C. insignis*, which is the type species of the section *Insigniae* J.Moravec (1990). *C. insignis* is distinguished by the subglobose to discoid shape of the apothecia, and especially, by the type of hairs, which have bulbous or even truncate roots at their base, are rigid, thick-walled, and have numerous septa. For these features, the section *Insigniae* is in fact much closer to the section *Cheilymenia*, which is represented by three species including the type species *Cheilymenia stercorea* (Fr.) Boud.in the present sense. A species with a similar type of hairs to those of *C. pulcherrima* is *Cheilymenia raripila* (Phill.) Dennis, which is the type species of the section *Raripilosae* J.Moravec(1990). Species of that section differ, however, from species of section *Paracheilymeniae* especially in shape of apothecia, and by very large ascospores, which bear a densely,irregularly reticulate perisporium.

Cheilymenia aurantiacorubra Thind et Kaushal, Indian Phytopath. 33:428, 1980.

Apothecia 0.2-0.5 mm diam., scattered or densely clustered together, sessile, subglobose to subturbinate to barrel-shaped with flattened, smooth, orange to orange-red hymenium, external surface orange-red, usually pink at the base, covered with pale brown hairs; margin entire, slightly raised, fringed with hairs. **Hairs** 95-210(-250) x 6-16(-20) µm, superficial,pale brown, 1-3 septate, with walls 0.4-1.5 µm thick, straight, apices acute, subacute to obtuse, swollen at the base, the base usually bulbous or conical, arising from cells of the ectal excipulum, the cells under


2
= 6 µm
c
= 20 µm
b
= 30 µm
d
a
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e
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Fig. 2. Cheilymenia aurantiacorubra: **a**. Apothecium; **b**. Hairs; **c**. An ascospore under oil immersion + CB; **d**. Ascus and paraphyses; **e**. Section of the marginal part of an apothecium. (Isotype BRA, J.Mor.).

the base of hairs often abortive; hairs of the lower surface of apothecia hyphoid, septate. Hyaline hyphae also present near the base of apothecia. **Ectal excipulum** of textura globulosa-angularis, composed of subglobose to ellipsoid to angular cells, 15-45 µm diam., becoming smaller and vertically arranged towards the margin of apothecia , the upper marginal cells clavate.

Medullary excipulum inconspicuously or nearly not differentiated from the ectal layer, composed of mostly angular cells, which are 15-25(-35) µm diam., with occasionally elongated cells or short hyphae, which are 5-8 µm thick.

Asci 200-240(-250) x (13-)15-18 µm, cylindric, with apex obtuse or truncate , the base shortly attenuate, eight-spored.

Ascospores uniseriate, broadly ellipsoid, (15-)16.3-19 (-21.3) x (9-)10-12(-13) µm, the mature ascospores with yellow refractive contents when stained with CB, with a loosening, smooth or only occasionally wrinkled perisporium.

Paraphyses filiform, 3-4 µm thick, straight, septate, simple or rarely branched below, with apices enlarged to 4.5-6(-8) µm, containing orange granular contents.

Habitat: On cow dung.

Specimens examined:

1.India: Savanapur, Chandigarh, on a dung heap, Feb.10,1974 leg. S.C.Kaushal.(Isotype BRA,J.Mor. ex PAN 2584 holotype);

2.Finland: Tavastia australis, Tamela, Mustiala, in fimo vaccino 7.X. 1889 leg, P.A.Karsten (H 2977 and H 2978)- two packets containing basically the type collection of Ascophanus flavus Karst. = Cheilymenia karstenii J.Moravec (1990)- besides numerous apothecia of C. karstenii, apothecia of C. aurantiacorubra are associated with apothecia of other coprophilous discomycetes e.g. Lasiobolus sp., Ascophanus brunnescens P.A.Karst. and Ascobolus sp. on the same substrate of the Karsten's collection;

3. Macaronesia: Canary Islands, Tenerife, 11 km NE of La Laguna in the Anaga Mts., Paso, alt. c. 900 m., on cow dung, associated with Lasiobolus sp., C. lundqvistii and other discomycetes, 23.I. 1973 leg. N. Lundqvist (UPS 8212-c, temporarily in CUP-MM 2771- a mixed collection within the packet for CUP-MM 2573 from which CUP-MM 2573, 2771 and 2772 were taken). Also another collection from the same locality, CUP-MM 2773 ex UPS 8212-a deposited temporarily within the packet for CUP-MM 2559 until it is sent back to UPS, contains apothecia of C. aurantiacorubra mixed with apothecia of other discomycetes. (The former Macaronesian collection (CUP-MM 2771) was published under "Cheilymenia sp.2771" by Korf & Zhuang (1991)).

C. aurantiacorubra is undoubtedly very close to C. pulcherrima and could even be considered as a variety. It differs especially in ascospore size. The ascospores of C. aurantiacorubra do not exceed 22 x 13 µm, whilst these of C. pulcherrima may reach up to 27 x 15 µm. The other characters are very similar except the shape of apothecia which seem to be more turbinate in C. pulcherrima. Moreover, the colour of the apothecia of C. aurantiacorubra was described as orange-red (Thind & Kaushal 1980). For the time being, I keep these two taxa as independent species. After examination of the

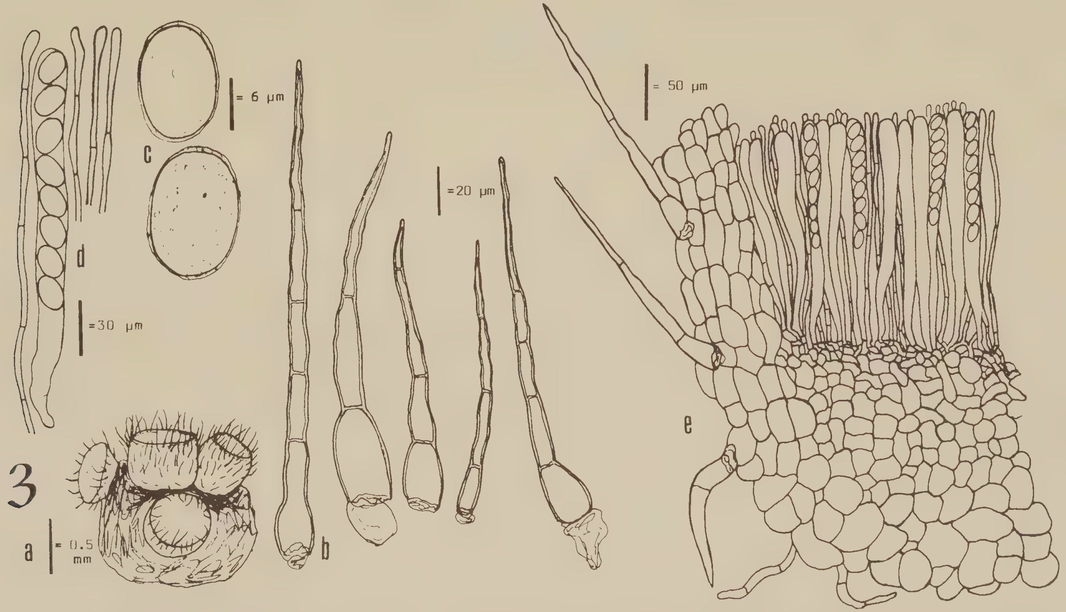
3
a
= 0.5 mm
b
c
= 6 µm
d
=30 µm
=20 µm
e
= 50 µm

Fig.3. Cheilymenia lundqvistii: **a.** Apothecia, **b.** Hairs; **c.** Ascospores; **d.** Ascus and paraphyses; **e.** Section of the marginal part of an apothecium (Holotype UPS 8212-c, temporarily in CUP-MM).

type and other collections, I have found only slight differences from the original diagnosis. In particular, the anatomy of apothecia is much more simple in the description given by Thind et Kaushall (1980).

Cheilymenia lundqvistii J.Moravec spec. nov.
(= "Cheilymenia sp. 2573" in Korf & Zhuang, Mycotaxon 40:90, 1991.

Apothecia gregaria, minuta, 0.3-0.6 mm diam., subglobosa dein breviter crasse doliiformia, crasse cupularia,tota pallide griseo-luteola, extus pilis brevibus brunneolis obsita; thecio applanato usque subpulvinato. Pili superficiales, 60-245 x 7-22 µm, recti, basi simplices, bulbosi, e cellulis ecrescentibus, sursum subacuti vel acuti, septati, tenuiter tunicati, membranis 0.3-1.3 µm crassis, irregulariter undulatis. Excipulum externum textura globuloso-angulari, excipulum inferiore e textura angulari hyphis brevibus parvis mixtum. Asci 150-200 x 11-15 µm cylindracei, apice obtusi, octospori. Paraphyses filiformes, 3-4.5 µm crassae, apice dilatatae (5-7 µm), subluteolae. Ascosporae monostichae, ellipsoideae, (11-)12-15 x 7.5-9 µm, eguttulatae, perisporio laevi, sublaevi, sed etiam minute verruculoso.
Habitat: ad excrementa vaccina.
Holotype: Macaronesia, Tenerife, prope La Laguna, Anaga Mts. Paso, alt. ca 900 m, 23.I.1973 leg. N. Lundqvist. Typus UPS 8212-c et in CUP-MM 2573.

Apothecia 0.3-0.6 mm diam., gregarious, first subglobose, becoming broadly and rather low barrel-shaped to thickly cupuliform with flattened to nearly pulvinate hymenium, pale grey-yellowish, external surface covered with brownish hairs. **Hairs** 60-245 x 7-22 µm, straight but with conspicuously irregularly wavy walls, which are 0.3-1.3 µm thick, 1-4 septate, pale brown, with apices acute or subacute, superficial, arising from the cells of the ectal excipulum, the base of the hairs usually abortive. Hyphoid hairs and septate hyphae are also present on the lower surface of the excipulum. **Excipulum** only inconspicuously differentiated. The ectal layer of textura globulosa-angularis, composed of subglobose to ellipsoid, mostly angular cells, which are 16-40 µm diam., elongated and clavate, vertically arranged towards the margin of the apothecia. Medullary layer of textura angularis composed of golden yellow, angular cells which are 8-12 µm diam., occasionally intermixed with elongated cells or short hyphae, gradding to a thin hypothecium, which is composed of swollen, irregular, small cells and hyphae. **Asci** 150-200 x 11-15 µm, cylindric, with apex obtuse, and with a simple, shortly attenuated base.
Ascospores uniseriate, ellipsoid, (11-)12-13.6(-15) x 7.5-9 µm, eguttulate, with yellow refractive contents when the mature ascospores are stained with CB; perisporium loosening, smooth, secondary wrinkled, but rarely also covered by very small cyanophilic pustules (under oil immersion + CB).
Paraphyses filiform, 3-4.5 µm thick, septate, straight,with apex enlarged to 4.5-6.5(-7) µm, with yellowish contents.
Habitat: On cow dung.
Holotype: Macaronesia, Canary Islands, Tenerife, 11 km NE of La Laguna in the Anaga Mts., Paso, Alt. c. 900 m., shrubby steep slope facing the east, 23.I.1973 leg. Nils Lundqvist. The holotype in UPS 8212-c, temporarily in CUP-MM 2573.

The apothecia of C. lundqvistii are associated with apothecia of C. aurantiacorubra and other discomycetes, therefore CUP-MM 2573,2771 and 2772 were taken from this mixed collection. **Isotype**: a slide with mounted sections of apothecia taken from the holotype (temporarily in CUP-MM 2573 and J.Mor. until it is sent back to UPS).

All features of this new species agree well with those of the two species of the section Paracheilymeniae especially the type and shape of hairs, excipulum and ascospores. C. lundqvistii is distinguished from C. pulcherrima and C. aurantiacorubra sufficiently by its much smaller ascospores. Moreover, the shape and pale colour of its extremely small apothecia, and also the conspicuously irregularly wavy walls of hairs distinguish this taxon.

AN ADDITIONAL NOTE: C. CORNUBIENSIS EXCLUDED FROM CHEILYMENIA

In addition to the above introduction of the section Paracheilymeniae and notes on taxonomy, I wish to add one important result of the taxonomic revision of the genus Cheilymenia. The following new combinations are proposed here:

Melastiza cornubiensis (Berk.et Br.) J.Moravec comb. nov.
Basionym: Peziza cornubiensis Berkeley et Broome, Ann. Mag. Nat. Hist. ser. 2, 13:463, (n.767), 1854.
Syn.: Cheilymenia cornubiensis (Berk.et Br.) Le Gal, Rev. Mycol.18 (2):82, 1953.
Examination of the type material (K,NY) revealed that this taxon is a typical member of the genus Melastiza Boud. It differs only slightly from Melastiza chateri (W.G.Smith) Boud. in having slightly paler, brownish apothecial hairs and orange hymenium. Nevertheless, the hairs are septate, brownish, obtuse above, and the ascospores are of the same size and reticulate ornamentation as these of M. chateri.

It is difficult to understand why Peziza cornubiensis Berk. et Br. was transferred to Neottiella by Cooke (1876), and to Cheilymenia by Le Gal (1953). Massee (1895) in a redescription of Neottiella cornubiensis (Berk.et Br.) Cooke has given the colour of hymenium as "orange" and external surface "pale yellow dotted towards the margin with short blunt, thin walled septate hairs, slightly coloured" and the ascospores " becoming sparsely ornamented with minute warts at maturity". Such hairs and their distribution represent one of the typical features of Melastiza, and it is evident that it was known to authors. The fact that ascospores were considered warted was the result of the use of insufficient optics and staining methods. I have found no essential differences between M. cornubiensis and M. chateri. If M. cornubiensis should be identical with M. chateri or merely a form of it, the epithet "cornubiensis" has priority as it represents the oldest name for this taxon. The reason for the type examination was that this taxon was transferred to Cheilymenia by Le Gal (1953) and that such a concept has been generally adopted. Le Gal (1953) identified P. cornubiensis with Peziza campestris Crouan et Crouan, Fl.

du Finist.,p.53, 1867, on the basis of her examination of the type of the latter, and, consequently, she transferred P. cornubiensis to Cheilymenia. However, it was an evident error as the type of P. campestris, according to Le Gal's detailed description and illustration, is quite a different fungus. It represents a species of Cheilymenia belonging to the section Villosae J.Mor. ser. Obtusipilosae J.Moravec (1990). It has the same type and shape of apothecia and fibrillose, frequently septate or articulate hairs which are blunt above, as are those of Cheilymenia magnifica (W-y.Zhuang et Korf) J.Moravec (1990). Furthermore,the ascospores, bearing a separable perisporium covered by irregular fine warts are very similar. However, the ascospore size is quite different. Whilst the ascospores of C. magnifica measure 12.2-16.8 x 7.5-9(-10) µm, these of P. campestris are much larger, 17-23.5 x 11-13 µm. It is not identical with any other species of Cheilymenia and I propose a new combination here:

Cheilymenia campestris (Crouan et Crouan) J.Moravec comb. nov.
Basionym: Peziza campestris Crouan et Crouan, Fl. Finist. p. 53, 1867.

Peziza fibrillosa Currey was also transferred to Cheilymenia by Le Gal (1953a). Dennis (1978) compared Cheilymenia cornubiensis to Cheilymenia fibrillosa (Currey) Le Gal. I have examined the type (K) of P. fibrillosa and other collections of this taxon. It is distinct from M. cornubiensis.

P. fibrillosa has smooth ascospores, and is a member of the genus Tricharina Boud. as recently recombined to this genus by Yang et Korf (1985). Consequently, both Tricharina fibrillosa (Currey) Yang et Korf and also Melastiza cornubiensis (Berk.et Br.) J.Mor. are here excluded from the genus Cheilymenia.

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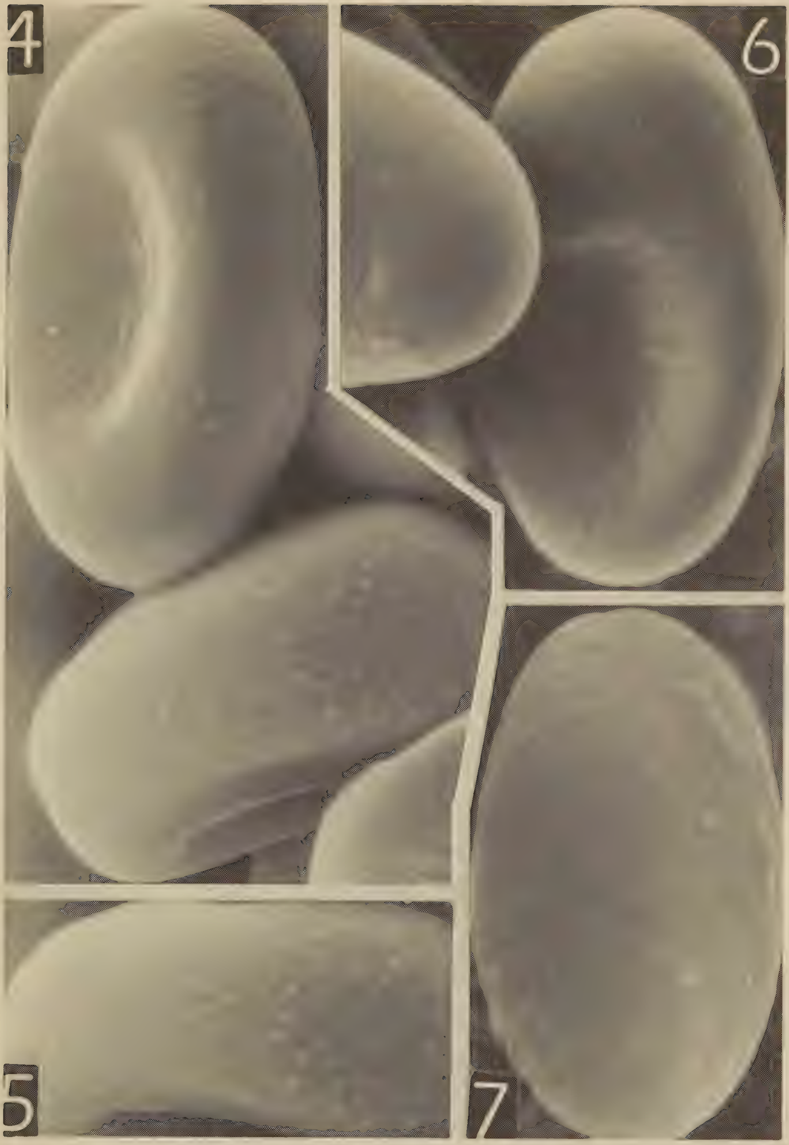
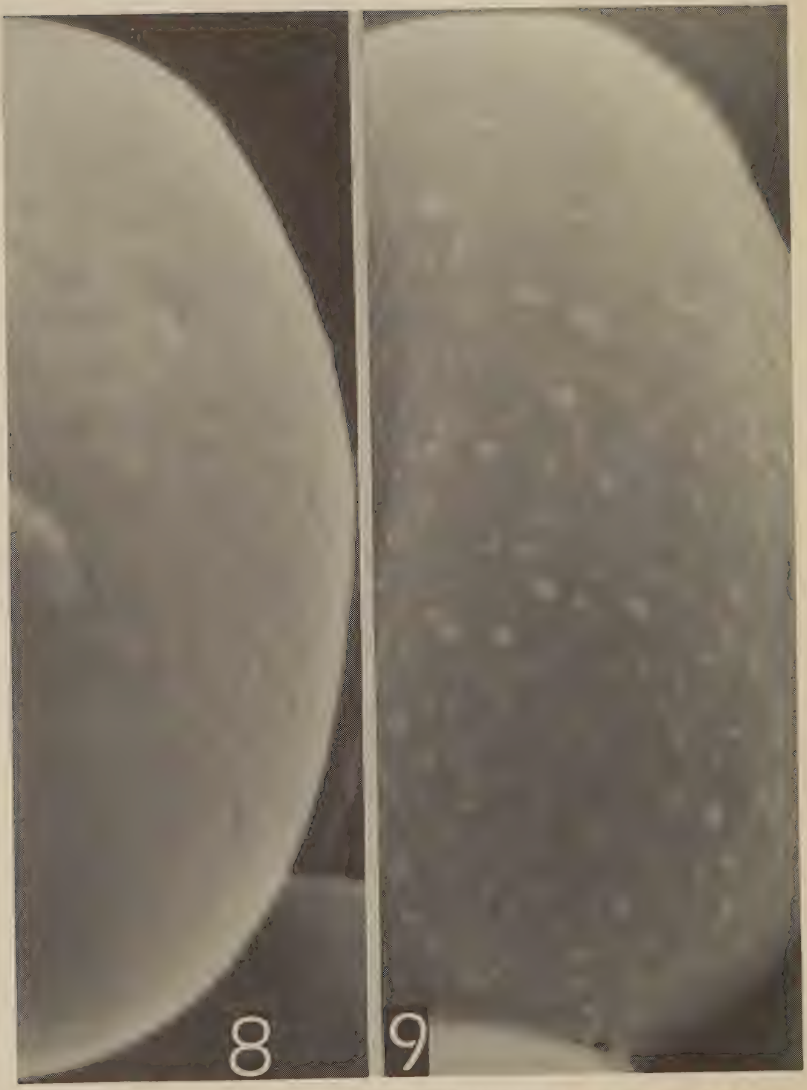


Figs.4-7. SEM photomicrographs of ascospores:
1-6. Cheilymenia pulcherrima (from Nannfeldt 409, PC);

7. Cheilymenia aurantiacorubra (Isotype BRA).



Figs. 8-9. SEM photomicrographs of ascospores (parts) of Cheilymenia pulcherrima (from Nannfeldt 409 PC).

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FUNGI OF NABOGAME, CHIHUAHUA, MEXICO

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ABSTRACT: A list is presented of 118 macrofungi collected from the vicinity of Nabogame, Chihuahua, Mexico. Of these, 27 are reported from Mexico for the first time: *Agaricus solidipes, Boletus affinis, B. bicolor, B. smithii, Cantharellus minor, Collybia cylindrospora, C. subnuda, Crepidotus malachius* var. *malachius, Disciceda pedicellata, Fomitopsis palustris, Gloeophyllum protractum, Heliocybe sulcata, Lactarius lignyotus, L. peckii, L. resimus, Lepiota brunnea, Marasmius splachnoides, Meruliopsis ambiguus, Oligoporus balsameus, Panaeolus papilionaceus, Ramaria candida, R. rasilispora, Russula rubescens, Seismosarca hydrophora, Steccherinum laeticolor, Suillus pinorigidus,* and *Tricholoma albobrunneum.* Sixty others are recorded as new to the state of Chihuahua.

RESUMEN: Se presenta una lista de 118 macromicetos procedentes de Nabogame, Chihuahua, México. De éstos, 27 se citan por primera vez la micobiota mexicana: *Agaricus solidipes, Boletus affinis, B. bicolor, B. smithii, Cantharellus minor, Collybia cylindrospora, C. subnuda, Crepidotus malachius* var. *malachius, Disciceda pedicellata, Fomitopsis palustris, Gloeophyllum protractum, Heliocybe sulcata, Lactarius lignyotus, L. peckii, L. resimus, Lepiota brunnea, Marasmius splachnoides, Meruliopsis ambiguus, Oligoporus balsameus, Panaeolus papilionaceus, Ramaria candida, R. rasilispora, Russula rubescens, Seismosarca hydrophora, Steccherinum laeticolor, Suillus pinorigidus,* y *Tricholoma albobrunneum..* Sesenta otros son nuevos registros del Estado de Chihuahua.

Floristic work on the fungi of the state of Chihuahua, Mexico, has been scanty. Pérez-Silva & Aguirre-Acosta (1986) list only 182 species collected from 13 sites in the state. Much of this work has been in the lowland desert portions of the state, although some work has been done in the montane regions of the Sierra Madre Occidental, which forms the border with Sonora. The mycoflora of the Sierra Madre shows strong affinities with that of the montane regions of the western United States (Guzmán 1973).

The site of our study was the village of Nabogame, Municipio Temósachi, Chihuahua. The town is located at 28°30′ N, 108°30′ W, at an elevation of 1800 m, 10 km east of the Sonoran state line (figure 1). The inhabitants are members of the Mountain Pima group of Native Americans (Laferrière & Van Asdall 1991). The town should not be confused with the larger Tepehuan community of the same name in southern Chihuahua.

The predominant natural vegetation of Nabogame is pine-oak forest, although human utilization has modified the natural cover (Laferrière 1991a). The agricultural portions of the community are surrounded by fields left fallow for various lengths of time. On steeper and rockier slopes the forest has been left largely intact although intense cattle grazing has reduced herbaceous vegetation. In moister areas along streambanks are located stands of sabino (Arizona cypress, *Cupressus arizonica* E. Greene), ahasiqui (a wild cherry, *Prunus gentryi* Standl.), and haya (bigtooth maple, *Acer grandidentatum* Nutt.). Madroño (madroño, *Arbutus xalapensis* H.B.K. and *A. arizonica* (A. Gray) Sarg.), fresno (ash, *Fraxinus papillosa* Lingelsheim and *F. pennsylvanica* Marsh. ssp. *velutina* (Torr.) Miller.), táscate (alligator juniper, *Juniperus deppeana* Steud. var. *robusta* Mart.), and manzanilla (manzanita, *Arctostaphylos pungens* H.B.K.) are also present (Laferrière et al. 1991a,b). A list of 612 species of vascular plants collected in the area is given by Laferrière (1991a, 1992b).

Rainfall in the area is bimodal, with spring and fall dry seasons separating the thunder shower season of July and August from the snow and light rain characteristic of the winter months. Beginning in August 1987, the region experienced a severe drought (Laferrière 1992a) which reduced the number of fleshy fungi fruiting.

Between October, 1986, and November 1988, the first author collected over 200 fungal specimens from the vicinity of Nabogame. Logistical constraints necessitated sun-drying of specimens for shipment to Tucson. The poor condition of some of the specimens prevented positive identification. Specimens of *Agaricus, Agrocybe, Amanita, Calvatia, Clitocybe, Collybia, Coprinus, Cortinarius, Hygrophorus, Inocybe, Lactarius, Lycoperdon, Russula, Sparassis,* and *Stropharia* were collected which could not be identified to species. Other specimens could not be identified to genus.

The specimens we were able to identify are listed below. For each species the substrate, month of collection, and the first author's collection numbers are given. Collection numbers lower than 1275 represent collections from 1987, while higher numbers were from 1988. Vouchers are on deposit at ARIZ. Duplicates of some of the species were sent to BPI, MEXU, and XAL.

Of the 118 species on the list, 28 are here reported from Mexico for the first time. Sixty others are reported for the first time from Chihuahua, although they have been recorded from other parts of Mexico (Acosta & Guzmán 1984; Anell & Guzmán 1987, 1988; Bandala-Muñoz et al. 1983, 1988; Bautista et al. 1986; Chacón & Guzmán 1983; Dubovoy et al. 1966; Estrada-Torres & Aroche 1987; García-Romero et al. 1970; Guzmán & Herrera 1971, 1973; Herrera & Guzmán 1966, 1972; Mendiola & Guzmán 1973; Pérez-Silva & Aguirre-Acosta 1985; Salcedo & Herrera 1966; Villarreal & Guzmán 1986). Two other collections have already been described as new species, i.e. *Polyporus tenuiparies* and *Albatrellus mexicanus* (Laferrière & Gilbertson 1990 a,b). Taken together, the Nabogame study represents a 48% increase in the number of macrofungi known from the state. An 𝕄 indicates a species reported from Mexico for the first time, while a ℂ represents a new report from Chihuahua.

ASCOMYCETES

HELVELLACEAE

HELVELLA LACUNOSA Afz.:Fr. Terrestrial under Arizona cypress. August. #1891. ℂ

HYPOMYCETACEAE

HYPOMYCES LACTIFLUORUM (Schw.:Fr.) Tul. On terrestrial *Lactarius* sp. in dry oak woodland. August. #770. ℂ

MORCHELLACEAE

MORCHELLA CRASSIPES Pers.:Fr. Terrestrial near creekbank under Arizona cypress. May. #475. ℂ

PEZIZACEAE

ALEURIA AURANTIA (Pers.:Fr.) Fuckel. Spores 7.5 x 14 µm, ornamented. Terrestrial under oak and madroño. August. #1851. ℂ

This is the southern, small spored variety mentioned by Arora (1986).

XYLARIACEAE

XYLARIA POLYMORPHA (Pers.:Fr.) Grev. On oak. May and August. #447, 1720. ℂ

BASIDIOMYCETES

AGARICACEAE

AGARICUS ARVENSIS Schaeff.:Fr. Terrestrial near creekbank under Arizona cypress and *Ilex tolucana* Hemsl. August. # 961. ℂ

AGARICUS SILVATICUS Schaeff. Terrestrial under oak and Arizona cypress. August. #737, 745, 746, 773. ℂ

AGARICUS SILVICOLA (Vitt.) Sacc. Terrestrial on bank of dry creekbed under oak and ash. July and August. # 616, 1719, 1735. ℂ

AGARICUS SOLIDIPES Pk. Terrestrial in cowpasture. May and June. #438, 1453. 𝕄

ALBATRELLACEAE

ALBATRELLUS MEXICANUS Lafer. & Gilbn. Terrestrial under Arizona cypress. August. #1889. Type collection (Laferrière & Gilbertson 1990a).

AMANITACEAE

AMANITA *aff.* CAESAREA (Scop. per Fr.) Grev. Cap 10-18 cm across, plano-convex to plane, slightly umbonate, glabrous, dry to subviscid when moist, white, sometimes with very faint tannish tint, especially toward center; margin striate. Gills crowded, pale yellow. Annulus superior, membranous, pendulant, pale yellow. Stipe white, 12-18 cm tall, hollow, tapering toward apex. Volva 3-5 cm deep, membranous, white. Spores ellipsoid to subglobose, [4.5-] 6.0-8.5 [10.5] µm long, [3.5-] 4.0-5.5 µm wide, thin-walled, hyaline, nonamyloid; print white. Terrestrial in fields and open oak-pine woodlands. August. #927. ℂ

Called “hongo de comer”, i.e. “eating fungus”, by the Mountain Pima people, this mushroom is one of the few species of fungi the inhabitants of Nabogame consume (Laferrière 1991b). Cited as *A. tuza* Guzmán in Laferrière (1991a,b). This may be a new species but additional collections would be necessary to determine its relationships.

AMANITA CHLORINOSMA (Austin) Lloyd. Terrestrial in fields and oak woodlands. July and August. #1007, 1571, 1841. ℂ

AMANITA CITRINA Schaeff. Terrestrial in oak woodland. July and August. #702, 1585. ℂ

AMANITA FLAVORUBESCENS Atk. Terrestrial under oak and Arizona cypress. August. #821. ℂ

AMANITA FROSTIANA Pk. Terrestrial in pine-oak forest. August. #896. ℂ

AMANITA PANTHERINA (DC.:Fr.) Secr. Terrestrial under *Quercus hypoleuca* and *Arbutus xalapensis*. August. #820. ℂ

AMANITA PELIOMA Bas. Terrestrial in pine-oak forest. August. #895. ℂ

AMANITA VAGINATA (Bull:Fr.) Vitt. Terrestrial under *Quercus chihuahuensis* and *Q. durifolia.* August. #985, 1830.

AMANITA VIROSA (Fr.) Bertillon in DeChambre. Terrestrial in pine-oak forest. August. #767.

ASTRAEACEAE

ASTRAEUS HYGROMETRICUS (Pers.) Morg. Terrestrial under Arizona cypress. July. #1566.

AURICULARIACEAE

AURICULARIA AURICULA (L.:Fr.) Underwood. On oak. July and August. # 945, 1590, 1729, 1730. ℂ

BOLBITIACEAE

AGROCYBE PRAECOX (Pers.:Fr.) Fay *vel aff.* Terrestrial in mixed oak-pine-cypress forest. August. #1858.

The specimen matches the description given by Arora (1986) except that the species typically occurs in the spring.

BOLETACEAE

BOLETUS AFFINIS Pk. Terrestrial in oak forest under *Quercus viminea.* August. #819. 𝕄

BOLETUS BARROWSII A.H. Smith. Terrestrial in pine-oak forest. August. #1755. ℂ

BOLETUS BICOLOR Pk. Terrestrial in pine-oak forest. July. #544. 𝕄

BOLETUS EDULIS Bull.:Fr. Terrestrial in oak woodlands. August. #691, 751, 818, 894, 1806.

BOLETUS FROSTII Russell *apud* Frost. Terrestrial in pine-oak forest. August. #764.

BOLETUS SMITHII Thiers. Terrestrial in oak forest. August. #792. 𝕄

CHALCIPORUS PIPERATUS (Bull.:Fr.) Bat. Terrestrial under *Quercus chihuahuensis.* August. # 928. ℂ

Reported from Mexico as *Boletus piperatus* Bull.:Fr. (Estrada-Torres & Aroche 1987) or *Suillus piperatus* (Bull.:Fr.) Kuntze (Herrera & Guzmán 1972).

LECCINUM SCABRUM (Bull.:Fr.) S.F. Gray *vel. aff.* Terrestrial in pine-oak forest. August. #763. ℂ

The specimen does not match Miller's (1978) description of *L. scabrum* in that the cap is slightly viscid rather than glabrous.

STROBILOMYCES FLOCCOPUS (Vahl.:Fr.) Karst. Terrestrial in open oak woodland. July. #1557.

SUILLUS PINORIGIDUS Snell & Dick. Terrestrial in oak forest. July. #615. 𝕄

TYLOPILUS PLUMBEOVIOLACEUS (Snell & Dick) Singer. Terrestrial under Arizona cypress. August. #1803. ℂ

XEROCOMUS CHRYSENTERON (Bull.) Quél. Terrestrial in pine-oak forest. August. #766, 1117.

CANTHARELLACEAE

CANTHARELLUS MINOR Pk. Terrestrial in pine-oak forest. August. #1728, 1849. 𝕄

CLAVARIACEAE

CLAVICORONA PYXIDATA (Fr.) Doty. Terrestrial in oak and pine-oak forests. August. #889, 987, 988, 1867, 1892. ℂ

RAMARIA ARAIOSPORA Marr & Stuntz. var. RUBELLA Marr. & Stuntz. Terrestrial in oak forest. August. #846. ℂ

RAMARIA CANDIDA Corner. Terrestrial under Arizona cypress. August. #1893. 𝕄

The species is previously reported from Japan and Georgia (Corner 1970). We agree with Corner (1970) that this may be an albino form of some other species, possibly *R. rasilispora.*

RAMARIA RASILISPORA Marr & Stuntz. Terrestrial under oak and/or pine. August. #989, 1787. 𝕄

COPRINACEAE

ANELLARIA SEMIOVATA (Sow.:Fr.) Pears. & Dennis. On cow dung. August. #960, 1764. ℂ

Reported from Zacatecas as *Panaeolus semiovatus* (Sow.:Fr.) Lundell & Nannf. (Acosta & Guzmán 1984).

COPRINUS COMATUS (Müll.:Fr.) S.F. Gray. Terrestrial in pine-oak forest. August. #847.

COPRINUS MICACEUS (Bull.:Fr.) Fr. On oak bark. August. #771. ℂ

PANAEOLUS FIMICOLA (Fr.) Gill. On cow dung. July. #582. ℂ

PANAEOLUS PAPILIONACEUS (Bull.:Fr.) Quél. On cow dung. August. #649. 𝕄

CORTICIACEAE

MERULIUS INCARNATUS Schw. On oak. August. #842, 1721.

MERULIPOSIS AMBIGUUS (Berk.) Ginns. On living Arizona cypress. August. #1888. 𝕄

PHLEBIA INCARNATA (Schw.) Nakasone & Burdsall. On oak. August. #842, 1721. ℂ

Reported from Zacatecas as *Merulius incarnatus* Schw. (Acosta & Guzmán 1984).

CORTINARIACEAE

CREPIDOTUS MALACHIUS (Berk. & Curt.) Sacc. var. MALACHIUS. On oak. August. #1840. 𝕄

First report of this variety from Mexico, although var. *trichiferus* Hesler & A.H. Smith has been reported from Veracruz (Hesler & Smith 1965).

ROZITES CAPERATUS (Pers.:Fr.) Karst. Terrestrial in pine-oak forest. August. #891. ℂ

The spores are 8-12 x 5-7 µm, which is slightly smaller than those reported by Moser (1983), i.e. 11-14 x 7-9 µm.

DACRYMYCETACEAE

DACRYMYCES CHRYSOSPERMUS Berk. & Curt. On pine and Arizona cypress. August. #747, 887. ℂ

Reported from Mexico as *D. palmatus* (Schw.) Bres. (García-Romero et al. 1970; Mendiola & Guzmán 1973).

DACRYOPINAX SPATHULARIA (Schw.:Fr.) Martin. On oak or pine. August and September. #906, 1766. ℂ

DEMATIACEAE

BIPOLARIS RAVENELII (Curt.) Shoemaker. Common on *Sporobolus indicus* (L.) R. Br., especially along frequently used pathways. September. #1127.

GANODERMATACEAE

GANODERMA LUCIDUM (W. Curt.:Fr.) Karst. On oak. August. #694, 925, 932, 1774, 2274. ℂ

GEASTRACEAE

GEASTRUM SACCATUM Fr. *vel aff.* Terrestrial under oak and madroño, August. # 1734. ℂ

GEASTRUM TRIPLEX Junghuhn. Terrestrial under maple and Arizona cypress. August. #1706, 1707. ℂ

HYDNACEAE

DENTINUM REPANDUM (L.:Fr.) S.F. Gray. Terrestrial under oak. August. #1724.

Reported from Chihuahua as *Hydnum repandum* L.:Fr. (Pérez-Silva & Aguirre-Acosta 1986).

LEPIOTACEAE

CHLOROPHYLLUM MOLYBDITES (Meyer:Fr.) Mass. Terrestrial on sandy riverbank. August. #1708. ℂ

LEPIOTA BRUNNEA Farlow & Burt. Terrestrial in pine-oak forest. August. #886. 𝕄

MACROLEPIOTA PROCERA (Scop.:Fr.) Sing. Terrestrial under *Quercus chihuahuensis.* July and August. #799, 1484, 1502.

LYCOPERDACEAE

CALVATIA CYATHIFORMIS (Bosc.) Morgan. Terrestrial in grassy fields. July. #581, 1485.

DISCISEDA PEDICELLATA (Morg.) Hollos. Terrestrial in grassy fields. August. #739. 𝕄

LYCOPERDON MARGINATUM Vitt. Terrestrial in oak and pine-oak forests. August. #714, 1634. ℂ

Reported from Mexico as *L. candidum* Pers. (Guzmán & Herrera 1973).

LYCOPERDON OBLONGISPORUM (Pers.) Schwn. Terrestrial in grassy fields. July. #2318. ℂ

LYCOPERDON PUSILLUM (Batsch:Pers.) Schum. Terrestrial in grassy fields. July. #624. ℂ

Reported from Mexico as *Bovista pusilla* (Batsch.:Pers.) Pers. (Guzmán & Herrera 1973).

LYCOPERDON PYRIFORME Schaeff.:Pers. On oak. August. #899, 1008, 1850. ℂ

MYCENASTRUM CORIUM Desv. Terrestrial on sunlit creekbank. May. #441. ℂ

NIDULARIACEAE

CRUCIBULUM LAEVE (Huds. trans Relhan.) Kambly. On oak. August. #692, 760.

Reported from Chihuahua as *C. vulgare* Tul. (Pérez-Silva & Aguirre-Acosta 1986).

CYATHUS STERCOREUS (Schw.) de Toni in Sacc. On dung. August. #628.

POLYPORACEAE

ABORTIPORUS BIENNIS (Bull.:Fr.) Sing. Terrestrial in oak woodland. August. #701, 931. ℂ

FOMITOPSIS PALUSTRIS (Berk. & Curt.) Gilbn. & Ryv. On *Pinus arizonica*. August. #1633. 𝕄

GLOEOPHYLLUM PROTRACTUM (Fr.) Imazeki. On pine. October. #2222. 𝕄

GLOEOPHYLLUM SEPIARIUM (Wulf.:Fr.) Karst. On pine and Arizona cypress. August and October. #1763, 2221.

Reported from Chihuahua as *Lenzites sepiaria* (Wulf.:Fr.) Fr. (Pérez-Silva & Aguirre-Acosta 1986).

LENZITES BETULINA (L.:Fr.) Fr. On oak. August. #962, 1722. ℂ

OLIGOPORUS BALSAMEUS (Pk.) Gilbn. & Ryv. On living Arizona cypress. August. #1887. 𝕄

PHAEOLUS SCHWEINITZII (Fr.:Fr.) Pat. On dead oak wood, or terrestrial in oak forest, probably from buried wood. August. #888, 1632. ℂ

Reported from Mexico as *Romellia sistotremoides* (Alb. & Schw.) Murr. (Guzmán & Herrera 1971).

PHELLINUS GILVUS (Schw.:Fr.) Pat. On oak. August and October. #713, 719, 2142.

Reported from Chihuahua as *Polyporus gilvus* (Schw.) Fr. (Pérez-Silva & Aguirre-Acosta 1986).

POLYPORUS ARCULARIUS (Batsch:Fr.) Fr. On oak. May, July and August. #492, 598, 1759.

POLYPORUS TENUIPARIES Lafer. & Gilbn. On *Quercus chihuahuensis.* July. #602. Type collection (Laferrière & Gilbertson 1990b).

PYCNOPORUS CINNABARINUS (Jacq.:Fr.) Karst. On oak. May, August, and October. #433, 829, 2058. ℂ

SPONGIPELLUS PACHYODON (Pers.) Kotl. & Pouz. On oak. August. #1753. ℂ

SPONGIPELLUS UNICOLOR (Schw.) Murr. On living *Quercus chihuahuensis.* August. #1868, 1901. ℂ

Reported from Nuevo León as *Polyporus obtusus* Berk. (Guzmán & Herrera 1971).

TRAMETES CERVINA (Schw.) Bres. On oak. August, November. #1813, 2256.

TRAMETES VERSICOLOR (L.:Fr.) Pilát. On oak. August. #1723, 2149. ℂ

Reported from Mexico as *Polyporus versicolor* L.:Fr. (Pérez-Silva & Aguirre-Acosta 1985) or *Coriolus versicolor* (L.:Fr.) Quél. (Guzmán & Herrera 1971).

TRICHAPTUM ABIETINUM (Dicks.:Fr.) Ryv. On *Pinus arizonica.* August. #1816. ℂ

Reported from Mexico as *Coriolus abietinus* (Dicks.:Fr.) Quél. (Guzmán & Herrera 1971).

RUSSULACEAE

LACTARIUS HYGROPHOROIDES Berk. & Curt. var. HYGROPHOROIDES. Terrestrial under oak. August. #1805. ℂ

LACTARIUS INDIGO (Schw.) Fr. Terrestrial under oak, Arizona cypress, and ahuasiqui. August. #823, 1733.

LACTARIUS LIGNYOTUS Fr. Terrestrial under Arizona cypress. August. #1874. 𝕄

LACTARIUS PECKII (Burlingham) Sacc. Terrestrial in oak woodland. August. #930. 𝕄

LACTARIUS RESIMUS (Fr.) Fr. Terrestrial in pine-oak forest. August. #1821. 𝕄

LACTARIUS VOLEMUS (Fr.) Fr. Terrestrial in pine-oak forest. August. #1820. ℂ

LACTARIUS ZONARIUS (Bull.) Fr. Terrestrial in oak woodland. August. #774.

RUSSULA RUBESCENS Beardslee. Terrestrial under oak and madroño. August. #707. 𝕄

SCLERODERMATACEAE

SCLERODERMA VERRUCOSUM Pers. Terrestrial under *Quercus chihuahuensis.* August. #1004.

STECCHERINACEAE

STECCHERINUM LAETICOLOR (Berk. & Curt.) Banker. On dead branch of live *Quercus chihuahuensis.* August. #1002. 𝕄

STEREACEAE

STEREUM HIRSUTUM (Willd.:Fr.) S.F. Gray. On oak. August. #603, 1725, 1756, 1818, 1822. ℂ

STEREUM OCHRACEO-FLAVUM (Schw.) Ell. On oak. August. #1736. ℂ

TREMELLACEAE

EXIDIA GLANDULOSA Fr.:Fr. On oak. August. #1760. ℂ

SEISMOSARCA HYDROPHORA Cke. On oak. August. #717.
First report from Mexico.

TREMELLA MESENTERICA Retz.:Fr. On oak. August. #1738, 1807, 1827. ℂ

Reported from Mexico as *T. lutescens* Pers.:Fr. (García-Romero et al. 1970; Mendiola & Guzmán 1973; Pérez-Silva & Aguirre-Acosta 1985).

TRICHOLOMATACEAE

ARMILLARIA MELLEA (Vahl:Fr.) Kummer. Cap yellow-brown to tan, dry, caespitose; margin cream-colored. Gills white, becoming tan with age. Stipe cream-colored. Annulus hairy. Basidia simple-septate at the base.

Print white. On oak and *Pinus engelmannii*. August, September, and October. #1005, 1136, 2223.

Reported from Chihuahua as *Armillariella mellea* (Vahl:Fr.) Karst. (Pérez-Silva & Aguirre-Acosta 1986).

CLITOCYBE CANDIDA Bres. Terrestrial in pine-oak forest. August. #2336. ℂ

CLITOCYBE GIBBA (Pers.:Fr.) Kummer. Terrestrial under oak. August. #1718.

COLLYBIA CYLINDROSPORA Kauffman. On oak. #1483. 𝕄

COLLYBIA MACULATA (Alb. & Schw.:Fr.) Quél. Terrestrial in pine-oak forest. August. #708, 817. ℂ

COLLYBIA SUBNUDA (Ellis ex Pk.) Gilliam. On leaves of pine and *Quercus viminea*. August. #697. 𝕄

HELIOCYBE SULCATA (Berk.) Redhead & Ginns. On pine shingles of a house. July. #1495. 𝕄

Called "hongo de la casa" i.e. "house fungus" by the Mountain Pima.

HOHENBUEHELIA ANGUSTATA (Berk.) Sing. On *Q. chihuahuensis*. August. #843. ℂ

HOHENBUEHELIA PETALOIDES (Bull.:Fr.) Schulz. On oak. August. #1773. ℂ

LENTINELLUS URSINUS (Fr.:Fr.) Kuehner. On oak. August. #696. ℂ

LENTINUS LEVIS (Berk. & Curt.) Murr. On oak and madroño. July, August, and September. #695, 1134, 1527. ℂ

Reported from Mexico as *Pleurotus levis* (Berk. & Curt.) Singer (Bandala-Muñoz et al. 1988; Pérez-Silva & Aguirre-Acosta 1985).

LENTINUS STRIGOSUS (Schwein.) Fr. On oak. July. #1558. ℂ

Reported from Mexico as *Panus rudis* Fr. (Herrera & Guzmán 1972).

MARASMIUS SPLACHNOIDES Fr. Terrestrial in grassy field. July. #627. 𝕄

OMPHALOTUS OLEARIUS (DC.:Fr.) Sing. On buried wood in oak woodland, and terrestrial near large *Opuntia robusta* specimen in cowpasture. August. #893, 922, 1601. ℂ

SCHIZOPHYLLUM COMMUNE Fr.:Fr. On oak. August. #1761.

TRICHOLOMA ALBOBRUNNEUM (Pers.:Fr.) Kummer. Terrestrial in grassy field. August. #824. 𝕄

XEROMPHALINA CAMPANELLA (Batsch.:Fr.) Kummer. On dead Arizona cypress. August. #1859.

USTILAGINACEAE

USTILAGO ZEAE (Beckm.) Unger. On *Zea mays* L. #1022.
Often reported as *U. maydis* (DC.) Corda (Durán 1987). Called "hongo de maiz", i.e. "maize fungus", in Nabogame.

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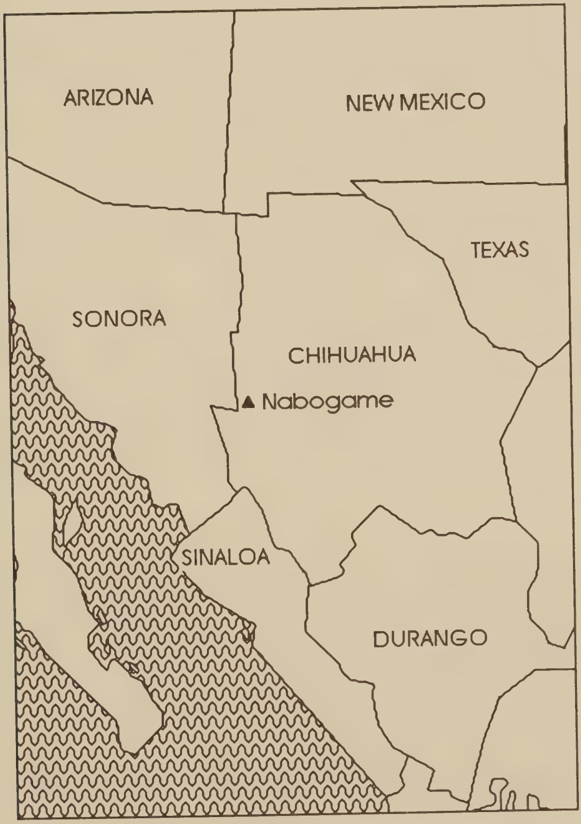
Figure 1: Map showing Mountain Pima village of Nabogame


ARIZONA
NEW MEXICO
TEXAS
SONORA
CHIHUAHUA
▲ Nabogame
SINALOA
DURANGO

MYCOTAXON

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SYSTEMATIC AND BIOLOGICAL STUDIES IN THE BALANSIEAE AND RELATED ANAMORPHS. II.

CULTURAL CHARACTERISTICS OF ATKINSONELLA HYPOXYLON AND BALANSIA EPICHLOE

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ABSTRACT

The cultural characteristics, including colony appearance and growth rates, and the morphology of the *Acremonium* and *Ephelis* synanamorphs, of *Atkinsonella hypoxylon* (Peck) Diehl, and the *Ephelis* anamorph of *Balansia epichloe* (Weese) Diehl, *in vitro* are described and illustrated. Comparison is made between these and some of the endophytic microconidial anamorphs of grasses classified in *Acremonium* Link, section *Albo-lanosa* Morgan-Jones & W. Gams.

INTRODUCTION

As indicated in the prologue to this series of papers (Morgan-Jones *et al.*, 1992), very few studies have been conducted on members of the Balansieae [Clavicipitoideae, Clavicipitaceae, Clavicipitales] *in vitro* and little information exists on variation among populations. Likewise, the cultural characteristics on agar media of species classified in the tribe having differing ecological relationships with their hosts are either not known or have only partly been investigated in a few. The majority of fungi classified in the Balansieae, particularly species of *Balansia* Speg., occur on members of the grass subfamily Panicoideae [see Diehl (1950); Clay (1988)]. In contrast to these, anamorphic fungi classified in *Acremonium* Link, section *Albo-lanosa* Morgan-Jones & W. Gams, that occur as symptomless endophytes of wild and pasture

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grasses belonging mostly to the subfamily Pooideae (syn. Festucoideae), have been extensively described in culture [see Morgan-Jones and Gams (1982); Clay (1986); Siegel *et al.* (1987); White and Morgan-Jones (1987c)]. These anamorphs, most of which are not known to produce conidia *in vivo*, are thought to be phylogenetically related to the Balansieae, and to *Epichloe typhina* (Tul.) Fr. in particular (Schardl and Siegel, 1991), which also occurs on the Pooideae. One, *Acremonium typhinum* Morgan-Jones & W. Gams, is the anamorph of that ascomycete.

Acremonium grass endophytes generally grow slowly on agar media (White and Morgan-Jones, 1987c) but usually do not sporulate well, although conidia are produced *in vitro* under most growing conditions. An exception is an unnamed endophyte of *Festuca versuta* Beal described by White and Cole (1986) that is not known to produce conidia *in vivo* or *in vitro*. In these anamorphs, conidia are borne on solitary, determinate, aculeate conidiogenous cells that arise from hyphae as lateral branches and are, in some species, delimited from them by a transverse basal septum, in others not (Morgan-Jones and Gams, 1982; Latch *et al.*, 1984). Their colonies are mostly white, at least when young, and lanose, hence the section designation *Albo-lanosa*. In this respect, they resemble members of *Verticillum* Nees section *Prostrata* W. Gams, which is typified by the microconidial anamorph of *Cordyceps militaris* (L.) Link, the type species of *Cordyceps* (Fr.) Link [Cordycipitoideae, Clavicipitaceae, Clavicipitales]. Species classified in that section of *Verticillium* have similar appearing, although faster growing, colonies in culture but differ from *Acremonium* grass endophytes in having verticillate conidiophores. *Acremonium chilense* Morgan-Jones, White & Piontelli, a recently described endophyte of *Dactylis glomerata* L. in Chile (Morgan-Jones *et al.*, 1990), has colonies that are similar to those of section *Prostrata* and is considered to be intermediate in its characteristics between that group and species classified in section *Albo-lanosa*. Considerable variation in cultural characteristics and growth rates is known to occur among *Acremonium* endophytes (White and Morgan-Jones, 1987c; Clay and Leuchtmann, 1989). The latter authors found a number of isolates, from a range of woodland grasses, to be to various degrees different from previously described taxa and some could not be identified with reasonable certainty. Christensen and Latch (1991) found cultural, morphological and physiological variation among thirty isolates of *Acremonium*, mostly *A. coenophialum* Morgan-Jones & Gams, from seeds of *Festuca arundinacea* originating in Algeria, Europe, North America, Australia and New Zealand. On account of smaller mean conidial length and, interestingly, failure to deter host-plant feeding by the aphid *Rhopalosiphium padi*, five of these isolates were thought to be possibly non-choke forming isolates of *Epichloe typhina*. Variation has also been documented to occur within isolates of *Acremonium* endophytes [*A. lolii* Latch, Christensen & Samuels] from perennial rye-grass [*Lolium perenne* L.] (Christensen *et al.*, 1991).

In order to compare *in vitro* characteristics of members of the Balansieae, other than *Epichloe typhina*, with *Acremonium* section *Albo-lanosa* anamorphs, *Atkinsonella hypoxylon* (Peck) Diehl and *Balansia epichloe* (Weese) Diehl have been brought into pure culture. Apart from belonging to different genera, these two fungi differ appreciably in their association with their respective hosts. *Atkinsonella hypoxylon* grows epiphytically around meristems, young leaves and inflorescences of its hosts, species of *Danthonia* L., including *D. compressa* Austin, *D. sericea* Nutt., and *D. spicata* (L.) Beauv., (Leuchtmann and Clay, 1988; 1989b). This epiphytic, localized habit is considered to be a primitive condition (White and Morgan-Jones, 1992) but infection by this fungus often results in destruction of the host inflorescence as stromata are formed. Concurrent with reduced fecundity, however, plants infected by *A. hypoxylon* show enhanced vegetative growth, perhaps due to diversion of energy from inflorescence maturation (Clay, 1984). *Balansia epichloe* is considered to have advanced beyond the condition in *A. hypoxylon* in that it has become partly endophytic. Its mycelium was reported by Rykard *et al.*, (1985) to be systemic and intercellular in buds, stems, and leaves of *Chasmanthium laxum* (L.) Yates and *Sporobolus indicus* (L.) Br. [as *S. poiretii* (Roem. & Schult.) Hitchc.]. In this respect, it is comparable to other grass endophytes such as, for example, *Balansia aristidae* (Atk.) Diehl, *Epichloe typhina*, and *Acremonium* spp. *Balansia aristidae* spreads systemically into successive tillers of *Aristida purpurascens* Poir. (Morgan-Jones, unpublished data). *Balansia epichloe* appears to do little damage to infected leaves and does not always adversely affect the reproductive capacity of its host, although it causes some energy loss that, in heavily infected plants, might result in no inflorescence being formed. Clay (1990) found flowering in ramets of *Sporobolus indicus* (smut grass) to be greatly suppressed when infected by *B. epichloe*. It was suggested that such inflorescence suppression might free energy resources for increased vegetative growth but in both infected and uninfected ramets this was not found to be appreciably different, neither was survivability. Both growth reduction and enhancement have been reported to occur in infected hosts (Clay, 1990; Diehl, 1950). Reduction in number of fertile tillers being formed in infected as compared to uninfected plants was thought by Porter *et al.* (1985) to be due either to nutrient drain or the effects of growth regulating compounds produced by *B. epichloe*. Following endophytic growth within leaf tissues, hyphae of *B. epichloe* emerge through stomata, or in between epidermal cells (Rykard *et al.*, 1985), to form a superficial primary stroma from which the *Ephelis* macroconidial anamorph is first formed, followed by the ascostroma. During the process of stroma maturation, hyphae of *B. epichloe* have been shown to penetrate between the epidermal cells and cuticle in the host grasses *Chasmanthium laxum* and *Sporobolus indicus* (Rykard *et al.*, 1985). It is thought that cuticle constituents might be an additional energy source for this process (White *et al.*, 1991) since progressive disintegration of this structure occurs during stroma development. In contrast to *A. hypoxylon*, *B. epichloe* has a comparatively wide host range, occurring on grasses belonging to the subfamilies Chloridoideae, Panicoideae and Pooideae.

MATERIALS AND METHODS

Isolates of *Atkinsonella hypoxylon* and *Balansia epichloe* were obtained from stromata collected from grass populations in Piscataway, New Jersey, and Montgomery, Alabama, respectively, during the summer of 1990. Three isolates of *A. hypoxylon* [1, 2 and 3] originated from stromata on three different vigorous, and otherwise healthy-appearing, plants from a population of *Danthonia spicata* which bore stromata on 20-40% of flowering culms. A fourth isolate [4] originated from a stroma borne on a relatively stunted plant from a cluster of such plants, all culms of which bore stromata. An isolate of *B. epichloe* was obtained from a stroma on a leaf of *Sporobolus indicus* [= *Sporobolus poiretii*].

Isolations were made as follows. Stromata were removed from host plants and surface disinfected by vigorous agitation in 50% Clorox solution for three minutes, after which they were washed in sterile, distilled water. They were then cut into pieces approximately 2 mm in diameter, using flame sterilized razor blades and plated on to potato dextrose agar [Difco]. Following incubation for three weeks at 25 C, plates were examined and subcultures prepared. Isolates were grown on a number of different agar media.

Media for cultural studies included PDA, glucose agar and fructose agar. The latter were prepared using Marashige and Skoogs Salt Base, 1.5% agar, and filter sterilized glucose and [D] fructose [1% or 3% wt./vol.]. In addition, 3% glucose agar media, supplemented with yeast extract [4% wt./vol.], biotin [100 mg/1], or thiamin [100 mg/1], were prepared.

For cultural studies and determination of growth rates, plugs of agar, approximately 2 mm in diameter, bearing mycelium, were cut from the margins of actively growing colonies growing on 1% glucose agar and placed at the center of petri dishes containing the growth media to be tested. Five replicates were prepared for each isolate/medium combination. Plates were sealed with parafilm and incubated at 25 C in darkness for 30 days, following which colonies were examined and colony diameters measured. Measurements were taken of each replicate of each isolate on all culture media. Mean colony diameter and standard error of growth rates were calculated.

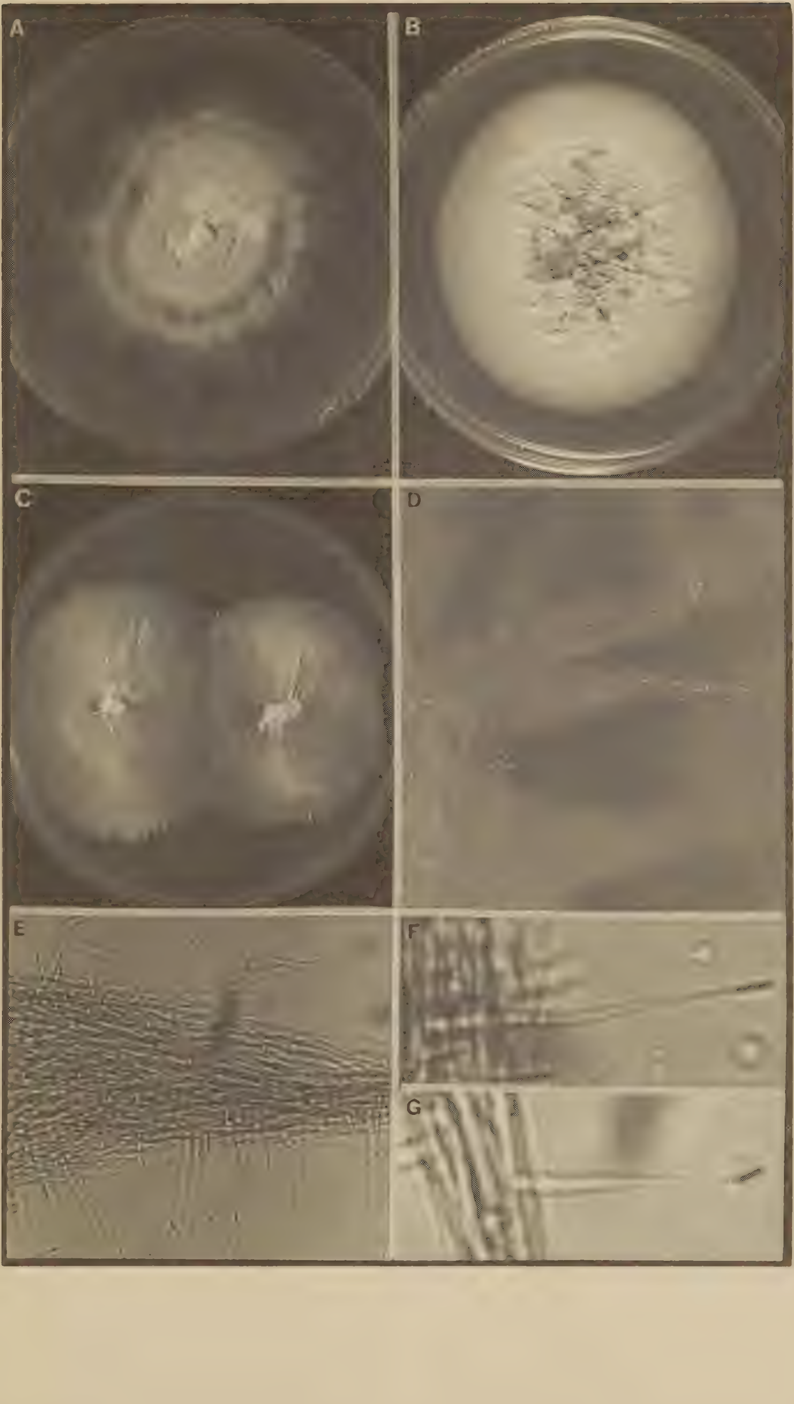
COLONY AND MORPHOLOGICAL CHARACTERISTICS

Atkinsonella hypoxylon

Isolates 1-3.

Colonies (Plate 1, A) attaining an average diameter of 71.5 ± 1.5 mm on PDA after 30 days at 25 C, loosely cottony to somewhat dense, lanose towards the center, at first white to cream, becoming ochraceous or slightly olivaceous with age, sometimes zonate, progressively sparse toward the periphery, margin thin, uneven, arachnoid; reverse whitish to olive. Colonies on 3% glucose agar slower growing, attaining an average diameter of 44.67 ± 2.84 mm after 30 days at 25 C, white to ochraceous, mycelium appressed to agar surface, appearing moist, with prominent, curved to undulate, radiating hyphal strands extending to

PLATE 1. *Atkinsonella hypoxylon*. A, Isolate 1, 30-day-old colony on PDA; B, Isolate 4, 30-day-old colony on PDA; C, Isolate 1, 35-day-old colony on 3% fructose agar; D, Isolate 4, *Acremonium* anamorph groups of compacted hyphae in the form of synnemata produced on 30-day-old colony on PDA; E, close up of synnema showing laterally borne conidiogenous cells; F & G, conidiogenous cells and conidia.


A
B
C
D
E
F
G

the extreme edge, margin waxy, fimbriate, scalloped; reverse white to cream colored, often with a whitish diffusible exudate visible. Colonies on 3% fructose agar (Plate 1, C) attaining an average diameter of 37.4 ± 6.75 mm after 30 days at 25 C, similar in appearance to those on glucose agar, but not becoming as yellowish and with more evident whitish exudate.

Colonies on PDA producing, after 2 weeks, *Ephelis* macroconidia only. Mycelium composed of smooth, septate, hyaline, 1.5-2.5 µm wide hyphae. Conidiogenous cells (Plate 2, B; Figure 1, E) holoblastic, sympodial, borne solitarily, terminally or on short lateral branches of aerial mycelium, more or less cylindrical, delimited by a transverse septum, often slightly swollen immediately or a short distance above the septum, attenuating gradually distally, 11-12 µm in length, occasionally up to 3 µm in diameter where widest. Delimiting septa thin, obscure. Conidia borne apically in succession, usually in groups of three to five, each conidium originating from a meristematic locus proximal to, but to one side and just below, that of the preceding conidium, acicular, straight or very slightly curved, aseptate, hyaline, 13-30 x 1-1.5 µm in size.

Isolate 4.

Colonies (Plate 1, B) attaining an average diameter of 75.4 ± 3.5 mm on PDA after 30 days at 25 C, white to cream to pale salmony, sometimes with a purple tinge toward the center, more or less evenly colored or, more often, irregularly patchy, densely lanose or, in part, somewhat velutinous and becoming felted with age, often with central portion somewhat tufted and occasionally faintly sulcate, and a wide, uniform, marginal zone, margin even; reverse colorless or very slightly purplish centrally. Colonies attaining an average diameter of 12 mm on 3% glucose agar after 30 days at 25 C, whitish to pale beige or reddish brown with age, appressed to the agar medium and moist in appearance, mycelium mostly immersed, margin even; reverse colorless or beige to reddish brown. Colonies attaining an average diameter of 13 mm on 3% fructose agar after 30 days at 25 C, similar to those on glucose agar.

Colonies on PDA producing, after 2 weeks, *Acremonium*-like microconidia only. Mycelium similar to that of isolates 1-3 but with some hyphae convoluted. Conidiogenous cells (Plate 1, E-G; Figure 1, B) probably phialidic, solitary, arising laterally from aerial hyphae as slender, determinate branches, oriented at more or less right angles to the parent hyphae, usually, but not always, delimited by a basal transverse septum located proximal to the juncture with the hypha, cylindrical but attenuating gradually over two-thirds of its length, straight or sometimes bent, 35-40 µm long, 2-2.5 wide towards the base, bearing a cluster of conidia at the extreme apex. On fructose and glucose agar conidiogenous cells borne on loose aerial hyphae. On PDA synnemata-like hyphae ropes or strands are formed (Plate 1, D & E; Figure 1, A) from which conidiogenous cells are abundantly produced. Strands made up of parallel, somewhat interweaving hyphae, dense and wide at the base but attenuating towards their tip. Conidia at first narrowly oblong, becoming predominantly ellipsoidal to somewhat ovoid, aseptate, hyaline, smooth, sometimes guttulate, 3-6 x 1-2.5 µm, borne and accumulating in small heads or clusters at the apex of the conidiogenous cells. Older conidia thicker-walled, swollen, broadly

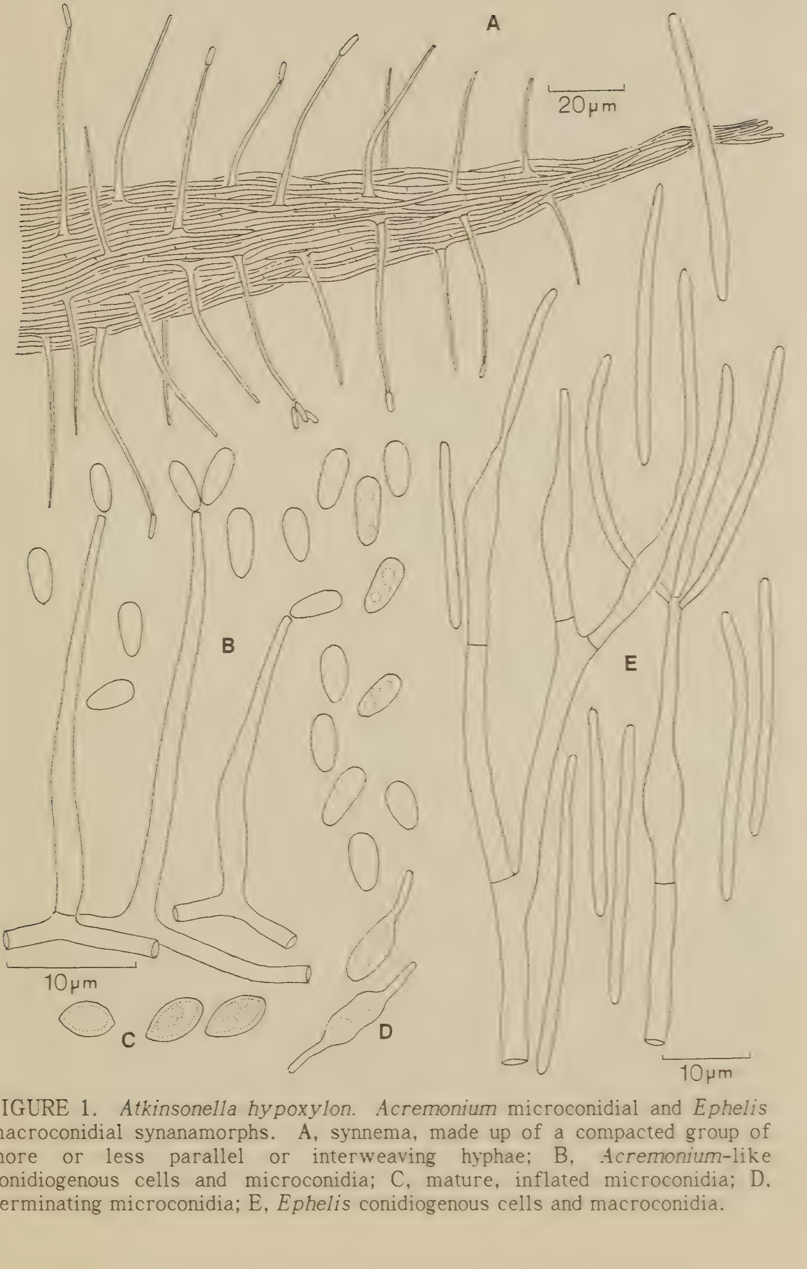


FIGURE 1. *Atkinsonella hypoxylon. Acremonium* microconidial and *Ephelis* macroconidial synanamorphs. A, synnema, made up of a compacted group of more or less parallel or interweaving hyphae; B, *Acremonium*-like conidiogenous cells and microconidia; C, mature, inflated microconidia; D, germinating microconidia; E, *Ephelis* conidiogenous cells and macroconidia.

ellipsoid, and sometimes very slightly papillate at each end. Conidial germination mono or bipolar (Figure 1, D).

Balansia epichloe

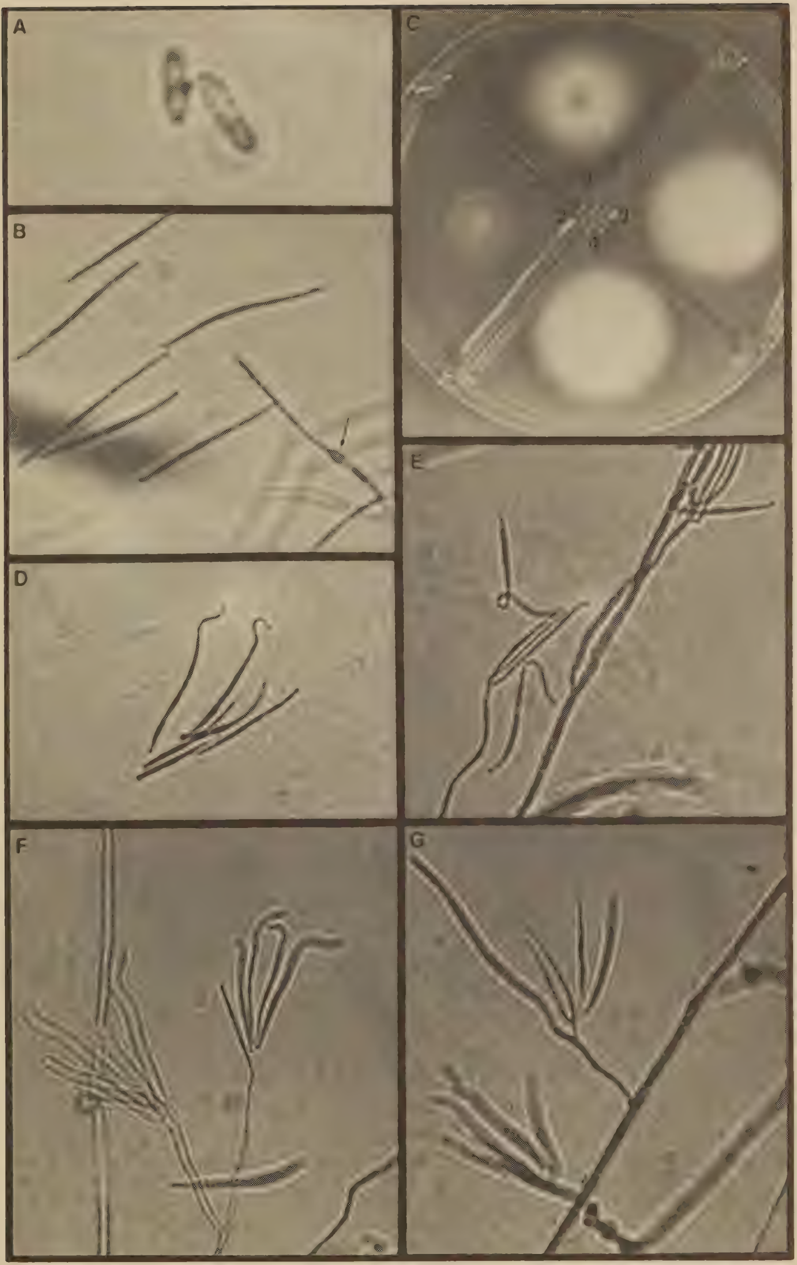
Colonies on PDA attaining an average diameter of 31.5 ± 3.8 mm after 30 days at 25 C, white, dense, lanose, with margin more or less even, but usually thin and rather ill-defined; reverse colorless. Colonies on 3% glucose agar, amended with yeast extract (Plate 2, C [3]), attaining an average diameter of 28.7 ± 3 mm after 30 days at 25 C; somewhat slower growing without amendment, attaining a diameter of 22 ± 0.82 mm under the same conditions. Colony appearance on the various media generally similar to that on PDA but aerial mycelia varying from sparse to dense. Colonies on 3% fructose agar, 6.6 ± 0.6 mm after 30 days at 25 C.

Mycelium composed of smooth, septate, hyaline, 1-2 µm wide hyphae. *Ephelis* macroconidial anamorph produced in culture. Conidiogenous cells holoblastic, sympodial, arising terminally and laterally from micronematous conidiophores that arise as lateral hyphal branches, solitary, in pairs, or, more rarely, in a verticil of three (Plate 2, E-G; Figure 2), cylindrical, attenuating slightly distally, varying in length, where lateral up to 22 µm, where terminal up to 100 µm. Conidia borne in succession apically, usually 3 to 5, occasionally up to 8, on each conidiogenous cell, filiform, more or less straight or slightly curved over much of their length, often bent or hooked towards their pointed distal end (Plate 2, D), narrowly subtruncate at the base, aseptate, hyaline, 17-27 µm long, 1 µm wide at the broadest part, 0.5 µm at the extreme tip.

DISCUSSION

In general appearance and coloration, colonies of *A. hypoxylon* and *B. epichloe* are broadly similar to those of the *Acremonium* anamorphs classified in section *Albo-lanosa*. The dense, deep, white, lanose colonies of *B. epichloe* are also reminiscent of those of *Acremonium chilense* and some species classified in *Verticillium* section *Prostrata*, which, as indicated above, is typified by the *Verticillium* anamorph of *Cordyceps militaris*, another member of the Clavicipitaceae. As has been discussed elsewhere (Morgan-Jones *et al.*, 1990), both of the anamorph form-genera *Acremonium* and *Verticillium*, as presently constituted, are artificial and heterogenous. Species classified in section *Prostrata* of the latter are, phylogenetically, probably closer to taxa classified in *Acremonium* section *Albo-lanosa* than they are to those placed in *Verticillium* section *Verticillium* typified by *V. tenerum* (Nees) Link, the anamorph of *Nectria inventa* Pethybr. While the growth rates of *A. hypoxylon*

PLATE 2. A, *Atkinsonella hypoxylon* microconidia (isolate 4); B, *Ephelis* macroconidial anamorph of *A. hypoxylon* (isolate 1) [arrow indicating conidiogenous cell]; C, *Balansia epichloe* colonies after 30 days [1, on thiamine & salt base; 2, on biotin & salt base; 3, yeast extract & salt base; 4, salt base alone]; D-G, *Ephelis* macroconidial anamorph of *B. epichloe*, conidiogenous cells and conidia.


A
B
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in vitro is appreciably faster than is typical of the *Acremonium* anamorphs [see White and Morgan-Jones, 1987c] that of *B. epichloe* is more typical of the group. In this regard, however, there is much variation, even within individual species. Isolates identified as *Acremonium starrii* White & Morgan-Jones, for example, originating from different host grasses, differ appreciably in growth rates (White and Morgan-Jones, 1987c). *Acremonium chilense* grows much faster than other species of section *Albo-lanosa* on a range of different sugar media (Morgan-Jones *et al.*, 1990). It is, perhaps, noteworthy that *A hypoxylon*, an epiphyte, has a higher growth rate *in vitro* than do endophytes such as *B. epichloe* and *Acremonium* spp.

In view of the documented variation, alluded to above, found among *Acremonium* endophytic anamorphs, including *A. coenophialum* and *A. starrii* White & Morgan-Jones (White and Morgan-Jones, 1987c; Christensen and Latch, 1991), the appreciable differences found in cultural expressions between isolates 1-3 from healthy looking plants of *Danthonia spicata* and isolate 4 from a stunted plant of that grass is of some interest. There is apparently biotype divergence among populations of these fungi. The fact that isolate 4 had not only a more detrimental effect on its host than the other three, but originated from among a group of stunted plants all of which bore stromata, indicates that it may be a more pathogenically aggressive biotype. The occurrence of only *Ephelis* macroconidia in cultures of isolates 1-3, whereas isolate 4 produced only *Acremonium*-like microconidia, also reflects a measure of divergence. The variation found in culture among some *Acremonium* endophytes makes classification at the species level problematic and reevaluation of the presently accepted taxonomy may be warranted (Morgan-Jones *et al.*, 1992). Variation encountered in *Atkinsonella hypoxylon* during the course of this study, however, allows anamorph species concepts to be viewed in better perspective. Leuchtmann and Clay (1989a) reported that *Acremonium* microconidia [referred to as '*Sphacelia* conidia'] were sparsely formed in cultures of *A. hypoxylon* and *A. texensis* (Diehl) Leuchtmann & Clay, the greater number being produced at 15 C on cornmeal dextrose agar and cornmeal malt-extract agar. At this temperature, *Ephelis* macroconidial production was found to be suppressed. No microconidia were observed in some isolates of *A. hypoxylon* whereas the *Ephelis* anamorph was produced after 2-4 weeks at 25 C in all six strains each of *A. hypoxylon* and *A. texensis* studied.

By referring to the microconidial anamorphs of *A. hypoxylon* and *A. texensis* as '*Sphacelia* states', rather than as being *Acremonium*-like, Leutchmann and Clay (1989a) perpetuated the sometime use of the generic name *Sphacelia* Lev. for anamorphs of the Clavicipitaceae other than those of *Claviceps* Tul. The type species of *Sphacelia*, *S. segetum* Lev., is the anamorph of *Claviceps purpurea* (Fr.) Tul. This use stems in large part from the naming of the microconidial anamorph of *Epichloe typhina* (Fr.) Tul. as *Sphacelia typhinum* Sacc., a binomial now considered to be a *nomen dubium* [see White and Morgan-Jones, 1987b], by Saccardo (1881). The anamorph of *E. typhina* is now, as indicated above, known as *Acremonium typhina* (Morgan-Jones and Gams, 1982). To justify naming the microconidial states of the two *Atkinsonella* species as *Sphacelia* anamorphs, Leuchtmann and Clay (1989a) cited a number of supposed differences between them and *A. typhinum*. These included the fact that conidiogenous cells in the latter are narrower and

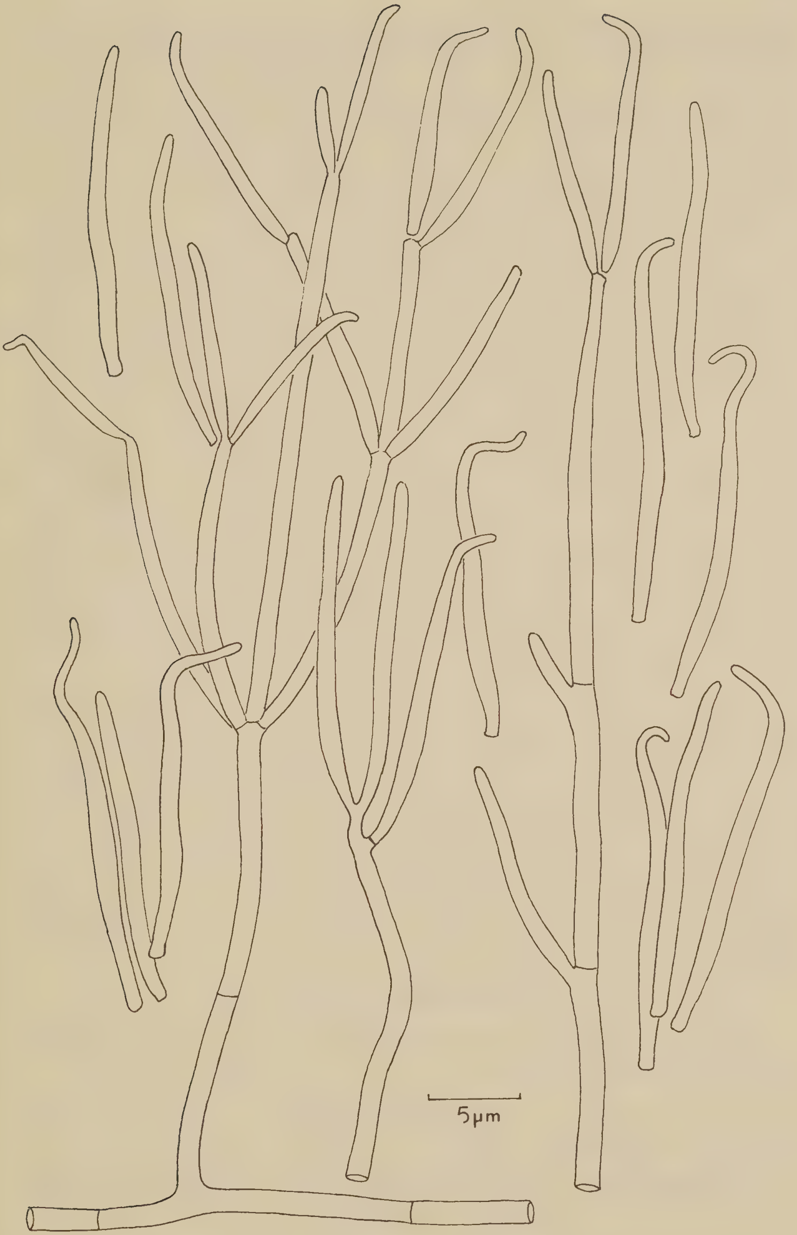

FIGURE 2. *Balansia epichloe. Ephelis* conidiogenous cells and conidia.

aculeate, gradually attenuating distally. They also noted, citing White and Morgan-Jones (1987b), that, *in vitro*, conidiogenous cells of *A. typhinum* occur solitarily and that its conidia are inequilateral rather than ovoid as in *Atkinsonella* microconidia. Leuchtmann and Clay (1989a) considered these differences, referred to as being fundamental [*sic*], to argue against a close relationship between *Atkinsonella* and *Epichloe* and viewed placement of *Atkinsonella* microconidial anamorphs in *Acremonium* section *Albo-lanosa* as inappropriate. Morgan-Jones and White (1989), following a study of *Atkinsonella texensis*, reached a different conclusion since the microconidial anamorph of this fungus was found to be quite similar in conidiogenous cell characteristics to *Acremonium typhinum*. The detailed morphology of conidiogenous cells of both *Atkinsonella hypoxylon* and *A. texensis* appears to vary, depending upon growing conditions. Under certain conditions *in vivo*, microconidial conidiogenous cells are arranged more or less parallel-sided in a close palisade upon a stromata made up of tightly packed hyphae and are relatively short, cylindrical over two thirds of their length, but often attenuate abruptly to give the distal third an aculeate aspect. In contrast, a much looser stromata can occur under different growing conditions as when in a humid environment, as illustrated in *A. texensis* by Morgan-Jones and White (1989). Conidiogenous cells that are very similar to those of species classified in *Acremonium* section *Albo-lanosa* arise from such stromata and are not arranged in a tight palisade. The *in vitro* study of *A. hypoxylon* reported herein confirms the similarity between the microconidial anamorph of this species and that of *E. typhina* and such species of *Acremonium* as *A. coenophialum*, *A. lolii* and *A. starrii*. The conidiogenous cells produced in culture are long, aculeate, and mostly borne solitarily. These are similar to those of some *Acremonium* species, particularly *A. coenophialum*, not only in shape but in lacking a septum, delimiting a separate cell from the repent hypha, at the base of the lateral conidiogenous portion. The synnemata of compacted hyphae, described above, interestingly, closely resemble those reported by White and Cole (1985) in *A. coenophialum* grown in axenic culture on seedlings of *Festuca arundinaceae* Schreb. With regard to conidium shape, two main types of conidia are known in *Acremonium* section *Albo-lanosa* [see Morgan-Jones *et al.*, 1992]. Conidia of *Acremonium chisosum* White & Morgan-Jones (White and Morgan-Jones, 1987a) and *A. chilense* are similar to those of *Atkinsonella* microconidial anamorphs in being equilateral. Those of the former are ovoid, essentially the same shape as the microconidia of *A. hypoxylon* and *A. texensis*. Microconidial shape is, therefore, not considered to be a reason for naming *Atkinsonella* microconidial anamorphs *Sphacelia* rather than *Acremonium* and their inclusion in *Acremonium* section *Albo-lanosa*.

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A KEY TO AND DESCRIPTIONS OF SPECIES ASSIGNED TO *OPHIODOTHELLA*, BASED ON THE LITERATURE

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ABSTRACT

A review of the literature yielded 26 species that have been described in or transferred to the genus *Ophiodothella* (Henn.) Höhn. Taxonomic descriptions have been compiled for each of these species, with additional comments where appropriate. As an aid to identification, a preliminary key to species and a host index based on the published information are provided.

Keywords: Ascomycotina, *Ophiodothella*, Phyllachoraceae, descriptions, key.

INTRODUCTION

Ophiodothella is a genus of obligate parasites that cause diseases of various plants in tropical and subtropical regions. All species occur on living leaves, and one, *O. orchidearum*, also attacks stems, flowers, and pseudobulbs. In about half of the species the lesions are described as amphigenous; in the rest they are either epi- or hypophyllous, but for six species lesion position was not designated. The fungus produces ostiolate perithecia in the leaf mesophyll which are covered by a characteristic black clypeus (pseudoclypeus). Depending upon the species, the perithecia may form in living leaves or on fallen leaves after overwintering. Filamentous paraphyses are reported in 14 species, including the type. The asci are unitunicate, cylindrical to fusiform, with an undifferentiated apex that may or may not stain blue in iodine (Melzer's Reagent). Each ascus contains eight hyaline, filiform ascospores which may be one-, two-, or several-celled. An acervulate anamorph with scolecosporous conidia has been described in one species, and a pycnidial anamorph has been reported in three others, one of which may be a spermatial state. Thus the majority of species appear to lack an anamorphic state.

---

[1] Deceased

Of the 26 species placed in *Ophiodothella*, only one, *O. ingae*, appears to have been transferred out of the genus. Since the genus has never been monographed, the validity of all of the species has not been confirmed, but on the basis of the published descriptions, they appear to fit the circumscription of the genus. Several of the descriptions, however, are incomplete. The primary points of disagreement in the descriptions are in ascospore septation (unicellular vs. septate) and the presence or absence of paraphyses. Both of these characters can be difficult to determine because of the age or condition of the material examined.

Ophiodothella species have been found on 45 species of host plants in 26 genera belonging to 15 families. Twelve host species belong to the Orchideaceae; all are attacked by *O. orchidearum*. Ten species occur on members of the Ericaceae. Eight species of *Ophiodothella* occur on species of *Vaccinium* and five on species of *Ficus*.

Species of *Ophiodothella* have been reported from 15 countries, all of which are located in tropical or warm temperate areas of the world. The most northerly species is *O. vaccinii*, which has been found in southern Illinois of the United States. The greatest number of species, eight, occurs in Brazil; six are found in the United States. The most widespread species is *O. orchidearum*, which is found in six countries in North, Central, and South America and in the Philippines. In the United States *O. vaccinii* occurs in nine states (Arkansas, California, Florida, Georgia, Illinois, Mississippi, North Carolina, South Carolina, and Texas).

The genus *Ophiodothella* was created by Hõhnel (1910) when he raised the subgenus *Ophiodothella* Hennings to generic rank, with *Ophiodothis atromaculans* Henn. as the basionym. Hennings (1904) had erected *Ophiodothella* to accommodate several species of *Ophiodothis* in which the asci were fusoid and lacked the thickened apical cap characteristic of species of *Ophiodothis*, which also had cylindrical asci. The type of *Ophiodothis* was later shown to be synonymous with *Balansia* in the Clavicipitales (Atkinson, 1905), necessitating the transfer of the species to other genera. Since the majority of the species in the genus had a well-developed, blackened, stromatic clypeus covering the perithecia, they were transferred to *Ophiodothella* (Hõhnel, 1910). Subsequently, some other species described under *Ceuthocarpon, Dothidea, Linospora, Oxydothis*, and *Scolecodothis* also were moved to the genus *Ophiodothella* (Barr, 1978; Petrak, 1951). Eriksson and Hawksworth (1987) list *Microphiodothis* Speg., *Scoledothis* Theiss. & H. Syd., and *Scolecodothopsis* F. Stev. as synonyms of *Ophiodothella*. *Ophiodothella* is considered closely related to *Phyllachora* and other members of the Phyllachoraceae (Polystigmataceae).

Ophiodothella was originally placed in the Dothideales on the basis of having no true perithecial wall (Clements and Shear 1931; Theissen & Sydow, 1915), but an ontogenetic study by Boyd (1934) showed a definite wall, which eventually led to the transfer of the genus to the pyrenomycetes. Although Boyd (1934) had suggested that the genus belonged in the Clypeosphaeriaceae in the Sphaeriales, Miller (1949) placed it among the Diaporthaceae. Müller and von Arx (1973) transferred the genus to the Polystigmataceae (Sphaeriales), whereas Barr (1976) placed it in the Melogrammataceae in the new order Phyllachorales. More recently, Cannon (1988) proposed placing the family in the Diaporthales, and Barr (1990), reversing her earlier arrangement, returned it to the Xylariales.

Most of the taxonomic literature of the genus *Ophiodothella* was published several decades ago and much of it was written in French, German or Latin. This paper presents a general taxonomic literature review of this genus. Descriptions in English are provided for each species, following a standard format and using current terminology. A preliminary key to species is compiled as and aid to identification. Descriptions are arranged alphabetically by specific epithet. Host names are taken from the literature and have not been checked for currency.

KEY TO SPECIES

1 On *Vaccinium caracasanum* .... *O. cuervoi*
1' On other host species 2
2(1') Ascus width 10 µm or more 3
2'(1') Ascus width 10 µm or less 15
3(2) Ascospore length more than 70 µm 4
3'(2) Ascospore length less than 65 µm 8
4(3) Ascospore width 2-4 µm, asci cylindrical or cylindric-clavate 5
4'(3) Ascospore width 4-6 µm, asci more or less fusiform 6
5(4) Leaf spot indefinite, ascus width 10-12 µm .... *O. galophila*
5'(4) Leaf spot distinct, ascus width 12-24 µm .... *O. vaccinii*
6(4') Ascospore length less than 100 µm 7
6'(4') Ascospore length more than 150 µm .... *O. longispora*

7(6)	Asci tapering gradually to base; scolecosporous anamorph present	*O. fici*
7'(6)	Asci short-stipitate; anamorph absent	*O. sydowii*
8(3')	Ascospore width more than 3 μm	9
8'(3')	Ascospore width less than 3 μm	12
9(8)	Perithecia less than 200 μm diameter	*O. leptospora*
9'(8)	Perithecia more than 200 μm diameter	10
10(9')	Ascus width less than 15 μm	*O. floridana*
10'(9')	Ascus width more than 15 μm	11
11(10')	Leaf spot amphigenous, asci clavate	*O. neurophila*
11'(10')	Leaf spot hypophyllous, asci fusoid	*O. circularis*
12(8')	Ascus length less than 80 μm	13
12'(8')	Ascus length more than 200 μm	*O. palmicola*
13(12)	Asci cylindrical to cylindric-clavate	*O. ingae*
13'(12)	Asci ellipsoid	14
14(13')	Asci ellipsoid, sessile; perithecia solitary in each stroma	*O. liebenbergii*
14'(13')	Asci clavate-ellipsoid, stipitate; perithecia 1-3 in each stroma	*O. edax*
15(2')	Asci cylindrical, not attenuated toward the apex	16
15'(2')	Asci fusoid or obclavate, more or less attenuated towards the apex	23
16(15)	Ascus width more than 8 μm	17
16'(15)	Ascus width less than 7 μm	20
17(16)	Leaf spots amphigenous, circular	18
17'(16)	Leaf spots hypophyllous, angular	*O. tarda*
18(17)	Perithecia several in each stroma	19
18'(17)	Perithecia single in each stroma	*O. bignoniacearum*
19(17)	Perithecia 2-3 in each stroma; ascus width 9.5-11 μm	*O. tithoniae*
19'(17)	Perithecia 5-10 in each stroma; ascus width 9 μm	*O. ulei*
20(16')	Ascus width average 7 μm	21
20'(16')	Ascus width less than 5 μm	22
21(20)	Perithecia single in each stroma; paraphyses abundant	*O. ferruginea*
21'(20)	Perithecia several in each stroma; paraphyses absent	*O. panamensis*
22(20')	Clypeus epiphyllous; paraphyses absent; ascus length 70-80 μm	*O. trichocarpa*
22'(20')	Clypeus hypophyllous; paraphyses present; ascus length 80-100 μm	*O. leucospila*

23(15') Ascospore length more than 50 μm 24
23'(15') Ascospore length less than 45 μm 25
    24(23) Ostiole prominently papillate; ascus size 50-70 x 5-8 μm . . . . *O. atromaculans*
    24'(23) Ostiole inconspicuous; ascus size 65-95 x 6-9 μm . . . . *O. orchidearum*
25(23') Perithecia more than 200 μm in diam . . . . *O. balansae*
25'(23') Perithecia less than 120 μm in diam . . . . *O. paraguariensis*

OPHIODOTHELLA (Henn.) Hõhn.

"Stroma phyllachoroid, occupying the entire leaf thickness, not erumpent. Asci clavate or cylindrical, without a mucilaginous cap. Paraphyses sparse or lacking. Locules single or a few, mostly soft. Spores hyaline, threadlike, rarely cylindrical" (Hõhnel, 1910).
Type species: *Ophiodothella atromaculans* (Henn.) Hõhn.

The genus was circumscribed by Hanlin (1990a) as follows: Ascoma an ostiolate perithecium, immersed in host tissue, single or clustered, with erumpent ostiolar neck surrounded by a black clypeus; perithecium brown, broadly obpyriform to laterally ovoid, with a single ostiolar neck, but sometimes ostioles amphigenous; ostiole lined with periphyses. Perithecial wall several layers thick, outer cells angular, moderately thick-walled and pigmented, inner cells thin-walled, hyaline and flattened. Centrum containing filamentous, branched paraphyses. Asci unitunicate, lining the perithecial wall, but arranged only at sides of perithecia with amphigenous ostioles, ellipsoidal to oval, short-stalked, with a thickened apex and amyloid pore, 8-spored. Ascospores filiform, 1-celled, lying parallel in ascus or coiled around one another, hyaline, but often appearing greenish, with a single row of oil droplets when freshly discharged.

SPECIES DESCRIPTIONS

1. ***Ophiodothella atromaculans*** (Henn.) Hõhn.
    Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 119:940 (1910).
    ≡ *Ophiodothis atromaculans* Henn. - Hedwigia 43:258 (1904).

Leaf spots amphigenous, forming an effuse, black stromatic crust, more or less covering the leaf. Clypeus amphigenous, gregarious, rounded-pulvinate, black and shiny, 250-300 mm diam. Perithecia few to solitary, immersed, subglobose with a papillate ostiole. Paraphyses sparse, filiform. Asci fusoid, attenuated towards the rounded apex, without a cap, substipitate, 8-spored, 50-70 X 5-8 μm. Ascospores filiform, parallel in the ascus, as long as the ascus, hyaline, pluriguttulate, afterwards multiseptate, 1.5-2 μm wide.

Anamorph: None reported.
Habitat: On living leaves of *Lonchocarpus* sp. (Fabaceae).
Distribution: Brazil.
Etymology: *atromaculans* = Latin, atro (black) + maculans (spotting), in reference to the black clypeus formed on the leaves.
Comments: Von Hőhnel (1910) reported that the original material had a thin, widespread, dark-brown stroma on both sides of the leaf containing groups of 2-5 perithecia ca. 260 μm wide X 220 μm high, but with the perithecia protruding more prominently on the lower side of the leaf. The leaf epidermis was filled with dark-brown, elongate hyphal cells that formed the carbonaceous clypeus above and below the perithecium. The dark hyphae penetrated somewhat into the adjacent mesophyll tissue but not into the interior of the leaf, so that the sides of the perithecia were delimited only by thin, pale, walls. The short ostiole formed on the underside of the leaf. Theissen and Sydow (1915) reported that the asci were cylindrical-clavate and that paraphyses were lacking. They gave the size of the asci as 65-75 X 6-8 μm and the ascospores as 45-52 X 2 μm.
References: Hennings, 1904 (Icon); Hőhnel, 1910; Theissen and Sydow, 1915; Saccardo, 1905.

2. ***Ophiodothella balansae*** (Speg.) Hőhn.
Fragmente zur Mykologie 12:65 (1910).
≡ *Ophiodothis balansae* Speg. - Fungi Guar. Pug. I, n. 291. (1885).

Leaf spots amphigenous, suborbicular, 5-15 mm wide, black, indeterminate. Clypeus ("stroma") innate (in leaf spots or near them), densely aggregated, suborbicular, rarely confluent, not prominent, often with one perithecium, coriaceous, wall indistinct, black, opaque. Perithecia globose-lenticular, 200-300 μm in diam., ostiole not prominent, center of perithecium filled with white matter. Paraphyses lacking. Asci obclavate, slightly thick-walled, apex attenuated and truncate, base abruptly narrowed, slightly pedicellate, 65 X 10 μm, 8-spored. Ascospores fasciculate-polystichous, aciculate, attenuated and acute at both ends, slightly curved, with a septum at the middle, not constricted at septum, guttulate, hyaline, with granular contents, 35-40 x 2.5 μm.
Anamorph: None reported.
Habitat: On living leaves of Bignoniaceae.
Distribution: Brazil.
Etymology: *balansia* = Latin, in honor of Benjamin BALANSA, a French collector of plants in Argentina.
References: Spegazzini, 1885; Saccardo, 1891; Hőhnel, 1910.

3. ***Ophiodothella bignoniacearum*** Chardon
Mycologia 32:178 (1940).

Leaf spots amphigenous, conspicuous, large, consisting of brown circular areas, 4-10 mm diam., provided with numerous black punctiform perithecia, visible on both surfaces of leaf. Perithecia single, globose to flattened, 220-300 x 180-216 μm, with clypeus above and surrounded by prosenchymatous wall, 6-10 μm thick. Ostiole short-papillate, with periphyses. Paraphyses present but inconspicuous with age. Asci cylindric, 8- spored, short-stalked, 72-85 X 8-9 μm. Ascospores filiform, hyaline, 1-celled, tightly pressed together in the ascus.
Anamorph: None reported.
Habitat: On living leaves of Bignoniaceae.
Distibution: Brazil.
Etymology: *bigoniacearum* = Latin, (on Bignoniaceae), for the host family.
Reference: Chardon *et al.*, 1940.

4. ***Ophiodothella circularis*** (Bres.) Petrak
Sydowia 5: 40 (1951).
≡ *Oxydothis circularis* Bres. apud Rick - Ann. Mycol. 4:311. 1906. (nom. nud.)
≡ *Scolecodothis circularis* (Bres.) Theiss. et H. Syd. - Ann. Mycol. 12:277 (1914).
= *Cocconia sphaerica* Rick - Fungi austro-amer. 72. (1906).

Leaf spots hypophyllous, indefinite or irregularly rounded, brown, up to 4 mm in diameter. Clypei situated in leaf spots, solitary or aggregated, black and shiny. Perithecia crowded, globose or cuboidal, 360-450 μm wide X 300-320 μm high. Asci slender, narrowed at both ends, short-stipitate, 105 x 18-22 μm, not blueing in iodine, 8-spored. Ascospores parallel, tetrastichous, straight or curved, hyaline, non-septate, 56-66 x 4-5 μm.
Anamorph: None reported.
Habitat: On living leaves of *Myrsines* sp. (Myrsinaceae).
Distribution: Brazil.
Etymology: *circularis* = Latin (circular), with reference to the rounded leaf spots.
Comments: The origin of this binomial is unclear. The reference provided for the basionym of this species by Theissen and Sydow (1915) is to an article by Rick (1906), who lists the fungus as occurring in South America. He gives no indication of the origin of the name or why it is attributed to Bresadola, nor does he provide a description. Saccardo (1926) later gave the citation for the transfer of *Oxydothis circularis* to *Scolecodothis* as Theissen and Sydow (1914), but this article contains no mention of this species. The actual transfer was made in a later paper (Theissen and Sydow, 1915), and *Cocconia sphaerica* Rick was listed as a synonym. The basionym thus appears to be a nomen nudum, as indicated by Saccardo (1926), who provided a Latin description.

References: Rick, 1906; Theissen and Sydow, 1914, 1915; Saccardo, 1926; Petrak, 1951.

5. *Ophiodothella cuervoi* Chardon apud Toro and Chardon
Ann. Mycol. 32:114. (1934).

Leaf spots ("stromata") epiphyllous or hypophyllous, rarely amphigenous, irregularly orbicular, convex, black, shiny. Clypeus of stromatic composition; lower wall cellular, indistinct. Perithecia solitary, depressed-globose. Paraphyses present. Asci clavate, 8-spored, few in number, pedicellate. Ascospores distichous, hyaline, non-septate, cylindrical, acute at both ends.
Anamorph: None reported.
Habitat: On living leaves of *Vaccinium caracasanum* (Ericaceae).
Distribution: Colombia.
Etymology: *cuervoi* = Latin, in honor of Luis Augusto CUERVO, historian and Governor of the Department of Santander del Norte, Colombia, site of the type collection.
Comments: No measurements were provided for this species.
References: Toro and Chardon, 1934; Petrak, 1935.

6. *Ophiodothella edax* (Berk. et Broome) Hőhn.
Fragmente zur Mykolologie 12:65 (1910).
≡ *Dothidea edax* Berk. et Broome - J. Linn. Soc. 14:135 (1875)
≡ *Ophiodothis edax* (Berk. et Broome) Sacc. - Syll. Fung. 2:653 (1883)

Leaf spots indefinite, consisting of a yellowish discoloration of the leaf tissue. Stromata occurring as elongated groups between veins, up to 3 mm long and 1 mm wide, with younger stromata forming in rings around the older ones. Single stromata amphigenous, mostly epiphyllous, but visible on opposite side of leaf, minute, punctiform, ca. 300 µm diam., usually confluent in groups. Stromata in mesophyll consisting of rather loosely reticulate, branched, hyaline to pale olivaceous brown hyphae which are 2.5-4 µm thick. Clypeus epidermal, amphigenous, brownish black, opaque, often somewhat raised and bluntly conical over the apex of the perithecia, 20-30 µm thick. Perithecia 1-3 in each stroma, globose or flattened globose, deeply immersed, 150-250 x 150-200 µm. Ostiole papillate or conically truncate, completely immersed under the clypeus, lined with periphyses. Perithecial wall subhyaline to pale brown, concentrically fibrose, 8-10 µm thick. Paraphyses not seen. Asci numerous, 8-spored, clavate-ellipsoid, pedicellate, 70-80 x 10-13 µm. Ascospores hyaline, filiform, parallel in ascus, non-septate, straight or curved, tapering somewhat to the blunt ends, 45-60 x 3-3.3 µm.
Anamorph: Berkeley and Broome (1875) stated that the leaf spots also bore bright scarlet tendrils composed of minute spores, which they considered a probable second form of fructification. Saccardo (1883) referred to these spores as probable

spermatia from a spermogonium. Von Hŏhnel (1910) considered them a true conidial state, which he called *Gloeosporium*-like. Doidge (1942) makes no mention of a second spore state in her description of South African material.
Habitat: On living leaves of *Tephrosia elongata* and *T. suberosa* (Fabaceae).
Distribution: Sri Lanka and South Africa.
Etymology: *edax* = Latin (destructive), an apparent reference to its parasitic habit.
Comments: Theissen and Sydow (1915) stated that they could not confirm the presence of paraphyses in this species, and Doidge (1942) did not observe them in her material. Theissen and Sydow (1915) also reported that the fruiting structures did not give a blue reaction in iodine.
References: Berkeley and Broome, 1875; Hŏhnel, 1910; Saccardo, 1883; Theissen and Sydow, 1915; Doidge, 1942.

7. ***Ophiodothella ferruginea*** (Ellis et G. W. Martin) M. E. Barr
Mycologia Memoir 7:131 (1978).
≡ *Linospora ferruginea* Ellis et G. W. Martin - Amer. Nat. 18: 69 (1884).
≡ *Ceuthocarpon ferrugineum* (Ellis et G. W. Martin) Berl. - Icon. Fung. 2:147, 153 (1900).

Leaf spots pale yellowish-brown, with a darker, narrow, slightly raised border, 1.5-2 mm wide. Perithecia solitary, one in the center of each spot, subglobose, 150 µm in diam., immersed and covered above by a black clypeus which is perforated by the scarcely prominent ostiole. Paraphyses abundant, filiform. Asci cylindrical, 8-spored, sessile or nearly so, 75-80 X 7 µm. Ascospores filiform, acute at each end, yellowish, 33-54 X 1.5-2 µm.
Anamorph: None reported.
Habitat: On living leaves of *Andromeda ferruginea* (Ericaceae).
Distribution: United States (Florida).
Etymology: *ferruginea* = Latin, ferrugo (the color of iron rust, i.e., rust-colored). Since the lesions in this species were not described as rusty brown, the specific epithet was probably based on that of the host.
References: Berlese, 1900 (Icon); Ellis and Martin, 1884; Barr, 1978.

8. ***Ophiodothella fici*** E. A. Bessey
Mycologia 11:55 (1919).

Leaf spots yellowish-green, with ferruginous margin, center occupied by a single black stroma or groups of concentrically arranged black stromata; heavily infected leaves fall prematurely in great numbers. Stromata 1-10 mm in diam., extending from the upper to the lower surface of the leaf, shiny black on the lower surface and whitish on the upper. Perithecia few or many in each stroma (depending upon stroma size), situated in the lower stroma but extending into the upper stroma, 400-450 X 300-500 µm, ostiole only very slightly papillate. Perithecial wall indistinct. Paraphyses filiform, septate, equal to the asci in length.

Asci numerous, 8-spored, arising in basal portion of the perithecium, elongate-fusiform, tapering gradually to the base and somewhat more abruptly to the rounded apex, 105-175 X 12-16 µm. Ascospores filiform, slightly clavate, dilutely brown, very granular, with a clear vacuole at middle of spore, not septate, 77-87 X 4.7-6.2 µm.

Anamorph: Pycnidia occuring in upper stromatic layer, appearing before the perithecia, ostiolate, 180-300 µm wide X 75-100 µm high; conidia elongate, slightly clavate, usually curved, rarely hooked, not septate, hyaline or dilute brown, 12-19 X 1 µm.

Habitat: On living leaves of *Ficus aurea* (Moraceae).

Distribution: United States (Florida).

Etymology: *fici* = Latin, (on *Ficus*), for the host genus.

Comments: The original description was in English, but Saccardo (1926) provided a Latin version.

References: Bessey, 1919 (Icon); Saccardo, 1926.

9. ***Ophiodothella floridana*** Chardon
J. Dept. Agric. Porto Rico 13(1):14 (1929).

Leaf spots large, conspicuous, roughly circular or irregular through coalesence, 8-15 mm across, amphigenous but more pronounced on the underside of the leaf, with a dull black, conspicuous stroma, 5-12 mm across, in the center of the spot, bordered by a distinct yellowish zone which borders the stroma on all sides; stroma with numerous perithecia (locules) in a row facing the undersurface, immersed in the mesophyll of the leaf, with heavy stroma above, lighter below; paraphyses present; perithecia globose or elliptical, 250-350 X 200-280 µm; asci cylindric-clavate, 8-spored, 80-112 X 11-13 µm; ascospores filiform, 1-celled, hyaline, 56-64 X 4 µm.

Anamorph: None reported.

Habitat: On living leaves of *Ficus* sp. (Moraceae).

Distribution: Puerto Rico, United States (Florida - Type).

Etymology: *floridana* = Latin, (from Florida), referring to the type locality.

Comments: This species was published only in English, but the name is valid as it was published before 1935 (Greuter *et al*., 1988).

References: Chardon, 1929; Petrak, 1929.

10. ***Ophiodothella galophila*** H. Syd.
Ann. Mycol. 23:383 (1925)

Leaf spots indefinite, consisting of a chlorotic zone, orbicular or irregular in outline, ca. 5-12 mm diam., often becoming rhomboid and limited by leaf veins, underside yellow, upper side dark reddish-brown, then becoming gray or grayish-black above and black below. Clypei ("stromata") irregularly scattered, often solitary, then 2-3 aggregated and somewhat confluent, visible on both sides

of leaf, composed of very densely interwoven hyphae 4-5 μm wide, coriaceous-gelatinous, with surface punctured by ostioles. Perithecia usually developed in middle of clypeus, irregularly distributed or densely crowded, mostly arranged in two rows, applanate-globose, rarely elliptical or ovate, 250-350 μm in diam.; ostiole truncate-conical, with periphyses. Perithecial wall ca. 15-20 μm wide, concentrically fibrous. Paraphyses broadly filiform, more or less attenuated toward the apex, becoming mucilaginous, 5-7 μm wide. Asci narrowly clavate or cylindric-fusiform, attenuated towards the base, rounded at the apex, subsessile or very shortly stipitate, thin-walled, 8-spored, sporogenous part 95-130 X 10-12 μm. Ascospores broadly filiform, parallel, usually curved, rarely almost straight, usually slightly attenuated at both ends, with granular contents or often guttulate, rarely indistinctly 3-4 septate, hyaline, 75-95 X 2.5-3.2 μm.
Anamorph: *Linochora galophila* H. Syd. This occurs in conjunction with the ascigerous state.
Habitat: On living leaves of *Ficus jimenezius* (Moraceae).
Distribution: Costa Rica.
Etymology: *galophila* = Greek, galo (milk) + philos = (loving), an apparent reference to the milky latex of the host.
References: Sydow, 1925a; Petrak, 1928.

11. ***Ophiodothella ingae*** (Henn.) Theiss. et H. Syd.
Ann. Mycol. 13:614 (1915).
≡ *Phyllachora ingae* Henn. - Hedwigia 48:8 (1908).

Although the ascospores in this species were originally described as filiform, Müller and von Arx (1962) and Cannon (1989) state that they are isthmoid and the species therefore belongs in *Diatractium*.
References: Hennings, 1908; Theissen and Sydow, 1915; Müller and von Arx, 1962; Cannon, 1989 (Icon).

12. ***Ophiodothella leptospora*** (Speg.) Höhn.
Fragmente zur Mykologie 12:65 (1910).
≡ *Ophiodothis leptospora* Speg. - F. Puigg. n. 331. (1887).

Leaf spots ("stromata") hypophyllous, innate, small, slightly raised, 5 mm in diameter, becoming ash-gray to dark bluish-gray, surrounded by a pale white areole, sparse or subaggregated, rarely confluent. Perithecia 2-5 in each stroma, crowded together, globose to angular, immersed, not raised, 120-150 μm in diameter. Paraphyses absent. Asci ellipsoidal or ovate, attenuate-rounded above, thin-walled, foveolate, abruptly short-stipitate, 50-60 X 10-22 μm, 8-spored. Ascospores cylindrical, crowded together, attenuated and rounded at both ends, non-septate, straight or curved, hyaline, 40 X 4-5 μm.
Anamorph: None reported.
Habitat: On living leaves of unidentified plant.

Distribution: Brazil.
Etymology: *leptospora* = Greek, lepto (slender) + spora (spore), with reference to the scolecosporous ascospores.
References: Spegazzini, 1887; Saccardo, 1891; Hõhnel, 1910.

13. ***Ophiodothella leucospila*** (Berk. et M. A. Curtis) Miller et Thompson
Mycologia 32:10 (1940).
≡ *Sphaeria leucospila* Berk. et M. A. Curtis - Grevillea 4:153 (1876).
≡ *Linospora leucospila* (Berk. & M. A. Curtis) Sacc. - Syll. Fung. 2:357 (1883).

Leaf spots consisting of light-colored areas along midrib and main lateral veins. Stromatic clypeus narrow, reduced in size, black. Perithecia hypophyllous, sunken in mesophyll under a black epidermal clypeus. Perithecial wall well organized, consisting of concentrically arranged cells that form a short papilla with a narrow ostiole which penetrates the clypeus. Paraphyses present, tending to disappear with maturity. Asci cylindrical, 8-spored, 80-100 X 4.6 μm. Ascospores filiform, about as long as the ascus and 1 μm thick.
Anamorph: None reported.
Habitat: On living leaves of *Platanus occidentalis* (Platanaceae).
Distribution: United States (Georgia, South Carolina - Type).
Etymology: *leucospila* = Greek, leuco (white) + spilo (spot), in reference to the light-colored lesions.
Comments: Ellis and Everhart (1892) include a description of this species, based on Berkeley (1876).
References: Berkeley, 1876; Saccardo, 1883; Ellis and Everhart, 1892; Miller and Thompson, 1940.

14. ***Ophiodothella liebenbergii*** Doidge
Bothalia 4:459 (1942).

Leaf spots pale brown, circular to irregular in outline, up to 10 mm in diameter, often numerous, becoming confluent and covering a large portion of the leaf. Stromata epiphyllous, scattered on the leaf spots, discrete or in small, closely crowded groups of 2-3, black, convex, shiny, up to 0.3 mm wide. Stromata in the mesophyll composed of rather loosely reticulate hyaline hyphae. Clypeus in the upper epidermis opaque, blackish-brown, 20-25 μm thick, up to 40 μm thick over the perithecial apex, not extending beyond the perithecium, composed of closely interwoven, dark olive-brown hyphae 2.5-4 μm thick. Perithecia solitary, subglobose or somewhat irregular in shape, deeply immersed in the mesophyll, 160-250 X 150-180 μm. Ostiole flat, truncateconical, immersed in the clypeus, lined with periphyses, with a more or less round pore 15-20 μm in diameter. Perithecial wall delicate, hyaline, 5-7.5 μm thick, closely appressed to the host mesophyll cells. Paraphyses sparse. Asci fairly numerous, 8-spored, ellipsoidal, rounded at the apex,

sessile, straight or somewhat curved, 65-75 X 10-15 µm. Ascospores linear, parallel but twisted in the ascus, hyaline, non-septate, 50-62.5 µm long X 2.5-3 µm wide at the rounded or truncate base and tapering gradually towards the apex, usually more or less sinuous.
Anamorph: None reported.
Habitat: On living leaves of *Ochna pulchra* (Ochnaceae).
Distribution: South Africa.
Etymology: *liebenbergii* = Latin, in honor of L. C. C. LIEBENBERG, a plant collector in South Africa who collected the original specimen.
Reference: Doidge, 1942.

15. *Ophiodothella longispora* Swart
Trans. Brit. Mycol. Soc. 79:567 (1982).

Perithecia single, immersed in host mesophyll, up to 600 µm in diam. Ostiole with periphyses, situated under a stroma, surrounded by a pseudoclypeus of dark host cells and some hyphae, wall composed of thin-walled hyaline cells, a smaller dark area may develop below the ascocarp in mesophyll and epidermis. Septate paraphyses present. Asci eight-spored, with a thick gelatinous wall without apical structures, 180-220 X 23-27 µm. Ascospores parallel, unicellular, 150-200 X 4-6 µm, with a gelatinous outer wall layer, somewhat curved, rounded at both ends.
Anamorph: None reported.
Habitat: On living leaves of *Eucalyptus goniocalyx* (Myrtaceae).
Distribution: Australia.
Etymology: *longispora* = Latin, longi (long) + spora (spore), referring to the long ascospores.
Reference: Swart, 1982 (Icon).

16. *Ophiodothella neurophila* H. Syd.
Ann. Mycol. 29:212 (1931).

Leaf spots scattered, amphigenous, irregularly angular or rarely orbicular in outline, on upper surface, at first yellowish brown, later turning reddish brown with a pale or greyish center, on the lower surface indistinctly yellowish or greyish-green, about 5-12 mm in diameter. Clypeus on both surfaces 25-50 µm wide, composed of dark brown cells 4-5 µm wide. Stromata mostly formed close to the leaf veins, immersed in the mesophyll, composed of extensively reticulate-branched yellowish to pale brown hyphae 3-5 µm wide. Perithecia globose, ovate or ellipsoidal, 250-350 µm in diameter. Perithecial wall membranaceous, 12-15 µm thick, composed of concentrically arranged greyish to olivaceous brown cells. Ostiole papillate, perforating the clypeus, lined with periphyses. Paraphyses very numerous, mostly simple, filiform. Asci numerous, 8-spored, clavate, much more attenuated towards the base, subsessile or very shortly stipitate, thin-walled, 70-90 X 15-25 µm. Ascospores polystichous, narrow and elongate-fusoid, attenuated towards both ends,

rounded at the tips, more or less sickle-shaped or sigmoid, rarely substraight, hyaline, 40-60 X 3-5 µm.
Anamorph: None reported.
Habitat: On living leaves of *Streptocaulon baumis* (Periplocaceae).
Distribution: Philippines.
Etymology: *neurophila* = Greek, neuro (nerve, vein) + philos (loving), in reference to the clustering of the stromata along the leaf veins.
References: Petrak, 1931; Sydow and Petrak, 1931.

17. ***Ophiodothella orchidearum*** Cash et Watson
Mycologia 47:734 (1955).

Diseased spots pale or indefinite whitish areas with dark margins on leaves, stems and other plant parts. Perithecia scattered over the leaf spot, subepidermal, lenticular to depressed-globose, with membranaceous wall, 300-500 X 200-300 µm. Ostiole 25 µm in diameter, short, inconspicuous, surrounded by a pseudoclypeus consisting of blackened host tissue. Paraphyses filiform, flexuous, guttulate, hyaline, 1-1.5 µm wide. Asci arcuate or straight, cylindric-fusoid, abruptly narrowed to a short stalk and attenuated toward the rounded apex, 8-spored, 65-95 X 6-9 µm. Ascospores elongate, straight or spirally twisted in the ascus, multiguttulate, 3-12 septate, often slightly constricted about one third the length from each end, hyaline to pale greenish, 55-66 X 1.8-3 µm.
Anamorph: None reported.
Habitat: On living stems, leaves, flower stalks, flower scapes, and pseudobulbs of *Cattleya mossiae, Cattleya* sp. *Laelia superbiens, Laelia* sp., *Odontoglossum uroskinneri, Oncidium bicallosum, O. cavendishianum, O. leucochilum, O. splendidum, Phalaenopsis schilleriana, Sobralia xantholeuca, Sobralia* sp. (Orchidaceae).
Distribution: Brazil, Colombia, Guatemala - Type, Mexico, Philippines, Venezuela.
Etymology: *orchidearum* = Greek, orchidea (orchid) + Latin -arum (belonging to), for the common name of the hosts.
Comments: This species was described from plants intercepted at United States ports of entry by Plant Quarantine Inspectors. It appears not to have been reported from the countries of origin.
Reference: Cash and Watson, 1955.

18. ***Ophiodothella palmicola*** Batista et Peres
Saccardoa 1:49 (1960).

Leaf spots epiphyllous, numerous, black, shiny, 1-2 mm wide, arranged in rows. Clypeus epidermal or immersed in mesophyll, dark brown, pulvinate, carbonaceous, 45-90 µm thick. Perithecia oblong-depresed, with papillate ostiole, extending from epidermis to mesophyll, aggregated, 690-900 X 75-160 µm, with a hyaline basal wall which is 7-12 µm thick. Paraphyses filiform, non-septate, hyaline, 0.1-0.2 µm thick.

Asci cylindrical or fusiform, unitunicate, 8-spored, sessile or short-stipitate, 200-240 x 10-13 µm. Ascospores fusoid-elongate or filiform, straight or curved, non-septate, hyaline, 22-25 x 2-2.5 µm.
Anamorph: None observed.
Habitat: On living rachis of an unidentified palm.
Distribution: Guyana.
Etymology: *palmicola* = Latin, palma (palm), + -icola (inhabiting), referring to the host.
Reference: Batista and Peres, 1960 (Icon).

19. *Ophiodothella panamensis* Stevens
Illinois Biol. Monogr. 11(2):44. (1927).

Leaf spots up to about 5 mm in diameter or larger by coalescence, irregularly circular, with a narrow yellow margin, each occupied by a single stroma. Clypeus epidermal, amphigenous, black. Stromata about 1-2 mm wide, visible on both leaf surfaces, dull black, rough, the upper subepidermal portion about 70-110 µm thick. The major portion of the stroma below the palisade layer is composed of colorless, thin-walled prosenchymatous cells, about 230 µm thick and 700-900 µm in diameter, extending also to some extent between the palisade cells and developing extensively between the cells of the spongy tissue. Perithecia several in each stroma, located in the mesophyll, globose, about 230 µm in diameter, with a papillate, hypophyllous, ostiole. Paraphyses lacking. Asci long, narrow, stalked, arising from all parts of the perithecial wall, 72 x 7 µm. Ascospores filiform, curved, obtuse, hyaline, 61-65 x 1.5 µm.
Anamorph: None reported.
Habitat: On living leaves of *Cordia heterophylla* (Ehretiaceae).
Distribution: Panama.
Etymology: *panamensis* = Latin, Panama (the country) + -ensis (origin of), referring to the type locality.
Comments: No Latin description was provided, but the name is valid as it was published before 1935 (Greuter *et al.*, 1988).
References: Stevens, 1927 (Icon); Petrak, 1928.

20. *Ophiodothella paraguariensis* (Speg.) Höhn.
Fragmente zur Mykologie 12:65 (1910).
≡ *Ophiodothis paraguariensis* Speg. - Fungi Guar. Pug. I, n. 292. (1885).

Leaf spots epiphyllous, rarely amphigenous, indefinite, 1-15 mm wide, becoming dry and rusty brown to black. Stromata epiphyllous, rarely hypophyllous, 260-320 µm in diameter, covered by black, shiny, slightly raised clypeus, concentrically arranged on the leaf spot. Perithecia solitary, but seldom 2-3 within a stroma, 80-220 µm in diameter. Asci 8-spored, fusoid or fusoid-subclavate, the upper part truncate and thick-walled, the lower part attenuated, slightly pedicellate,

50-60 x 7-9 μm. Ascospores fusoid-acicular, acutely rounded at both ends, straight or slightly curved, multiguttulate, 40-45 x 2-2.5 μm.
Anamorph: None reported.
Habitat: On living leaves of *Rollinia emarginata* (Annonaceae).
Distribution: Paraguay.
Etymology: *paraguariensis* = Latin, Paraguay (the country) + -ensis (origin of), for the type locality.
Comments: Spegazzini (1922) reported that the fungus was common on living leaves around Asunción, but that these specimens had asci 90 X 10 μm and ascospores 60 X 3 μm.
References: Spegazzini, 1885, 1922; Saccardo, 1891; Hőhnel, 1910.

21. *Ophiodothella sydowii* Petrak
Sydowia 2:63 (1948).

Leaf spots visible on both surfaces, irregularly dispersed, orbicular or elliptic to angular, 5-15 mm diam., often confluent, pale brown or reddish. Stromata only hypophyllous, irregularly dispersed or sometimes circularly distributed, 0.5-1.5 mm diam. Clypeus epidermal, black, 50-90 μm thick, pseudoparenchymatous, more or less raised. Perithecia globose or ellipsoid, 350-500 μm diam., ostiole bluntly conic, wall consisting of layers of pale olivaceous to subhyaline cells 3-5 μm in width. Asci fusiform or clavate-fusiform, the basal part more attenuated, short-stipitate, 120-150 x 17-24 μm. Ascospores parallel in ascus, narrowly elongate-fusiform, gradually attenuated to both ends, curved, rarely straight, hyaline, non-septate, 75-95 x 5-6 μm.
Anamorph: None reported.
Habitat: On living leaves of *Cavendishia* (Ericaceae).
Distribution: Ecuador.
Etymology: *sydowii* = Latin, in honor of the German mycologist, Hans SYDOW.
Reference: Petrak, 1948.

22. *Ophiodothella tarda* (Harkn.) Hőhn.
Fragmente zur Mykologie 12(630):65 (1910).
≡ *Ophiodothis tarda* Harkness - Bull. Calif. Acad. Sci. I, 2629. (1884).

Leaf spots hypophyllous, angular to irregular, 3-4 mm wide, often confluent. Perithecia with a papillate ostiole, covered by a black shiny clypeus. Asci 8-spored, cylindrical, abruptly contracted, curved and bulbose at the base, 57 x 9 μm. Ascospores filiform, pluriguttulate, 42 x 2 μm.
Anamorph: None reported.
Habitat: On living leaves of *Rhus diversiloba* (Anacardiaceae).
Distribution: United States (California).
Etymology: *tarda* = Latin, tardus (slow, tardy), referring to the delayed formation of the ascomata.

Comments: Harkness (1884) reported that the "fruit" formed slowly after lying long on the ground.
References: Harkness, 1884; Saccardo, 1891; Hõhnel, 1910.

23. ***Ophiodothella tithoniae*** Chardon apud Chardon et Toro
Mycol. Explor. Venezuela, Monograph Univ. Puerto Rico, Ser. B., 2:175 (1934).

Leaf spots amphigenous, more or less circular or slightly angular, more distinct on the upper leaf surface than on the lower, about 3 mm in diameter. Clypei ("stromata") dull black, somewhat angular, 2 mm wide, conspicuous and rugose above, scarely visible and brown on the lower leaf surface, always surrounded by a discolored zone of host tissue. Perithecia 2-3 in each stroma, lenticular, flattened, large, with a heavy black clypeus above, 200-350 x 160-200 µm. Paraphyses absent. Asci cylindrical to clavate, 8-spored, 68-82 x 9.5-11 µm. Ascospores filiform, hyaline, nonseptate, tightly appressed in the ascus, arcuate when free, 45-54 x 1.5-2.7 µm.
Anamorph: None reported.
Habitat: On living leaves of *Tithonia rotundifolia* (Asteraceae).
Distribution: Venezuela.
Etymology: *tithoniae* = Latin, (on *Tithonia*), for the host genus.
References: Chardon, 1934; Petrak, 1935.

24. ***Ophiodothella trichocarpa*** H. Syd.
Leafl. Philipp. Bot. 9:3126 (1925).

Leaf spots distinct, amphigenous, orbicular, 3-8 mm in diameter, whitish to yellowish brown, with a narrow, raised brown border. Clypeus epidermal, distinct on the upper leaf surface, not or scarcely developed on the lower surface, convex, black and shiny, covering the solitary perithecium, 20-25 µm thick. Perithecia epiphyllous, loosely aggregated on the leaf spot, situated in the leaf mesophyll, occupying 2/3 to 3/4 the thickness of the leaf, 250-400 µm wide. Paraphyses absent. Asci cylindrical, delicate, shortly pedicellate, 70-80 x 3-4 µm. Ascospores hyaline, filiform, arranged parallel in the ascus, about as long as the length of the ascus, 0.75 µm wide.
Anamorph: None reported.
Habitat: On living leaves of *Dracontomelon cumingianum* (Anacardiaceae).
Distribution: Philippines
Etymology: *trichocarpa* = Greek, tricho (hair) + carpo (fruit), perhaps in reference to the filamentous (hair- like) spore.
References: Sydow, 1925b; Petrak, 1928.

25. ***Ophiodothella ulei*** (Rehm) Hõhn.
Fragmente zur Mykologie 12:64 (1910).
≡ *Ophiodothis ulei* Rehm - Hedwigia 36:380 (1897).

Leaf spots amphigenous, orbicular, scattered, dull black, flat, irregularly rounded, often confluent, later becoming whitish, up to 3 mm in diameter. Stromata amphigenous, mostly hypophyllous. Clypeus up to 2 mm in diameter, flat, black and somewhat shiny, 20-25 µm thick. Perithecia 5-10 immersed in the mesophyll, 200-230 µm wide x 160-185 µm high. Paraphyses absent. Asci cylindrical, sessile, 8-spored, 85-100 x 6-8 µm. Ascospores filiform, guttulate, hyaline, arranged parellel in ascus, non-septate, 75-85 x 1-1.5 µm.
Anamorph: None reported.
Habitat: on living leaves of Fabaceae.
Distribution: Brazil.
Etymology: *ulei* = Latin, in honor of Ernst Heinrich Georg ULE, a German who collected plants for the National Museum in Rio de Janeiro.
References: Rehm, 1897; Saccardo, 1899; Hõhnel, 1910; Theissen and Sydow, 1915.

26. ***Ophiodothella vaccinii*** Boyd
Mycologia 26:465 (1934).

Leaf spots amphigenous, circular, light yellow when young, upper surface becoming reddish-orange or occasionally red when mature, often with a yellow halo, lower surface ocher to pale yellow-orange, up to 2 cm in diam., bearing numerous conidiomata, often turning black on fallen leaves. Ascoma an ostiolate perithecium, immersed in tissue of leafspot, formed in fallen, overwintered leaves. Perithecium obpyriform to oval, (120)-130-(150) µm high X (134)-155-(192) µm wide, usually with a single ostiolar neck but sometimes with amphigenous ostiolar necks; ostiolar necks surrounded by a black clypeus (pseudoclypeus), becoming papillate at maturity. Perithecial wall prosenchymatous, in amphigenous perithecia with pseudoparenchyma cells at the equator. Paraphyses hymenial, filamentous, septate, often branched, lining bottom and sides of perithecial wall, 79-112 x 3-4 µm. Asci numerous, arising among paraphyses, lining inside of perithecium, except in perithecia with amphigenous ostioles where they are restricted to sides of perithecium at equator and projecting inward, parallel to longitudinal axis of leaf. Asci unitunicate, cylindrical, tapered at base, slightly thickened at apex, 100-130 x 12-24 µm, often curved, with pore blueing in iodine, 8-spored. Ascospores hyaline, one-celled, filiform, usually slightly curved, 72-116 x 2-4 µm, with a single row of large oil droplets.
Anamorph: *Acerviclypeatus poriformans* Hanlin (Hanlin, 1990b).
Habitat: On living leaves of *Vaccinium arboreum, V. candicans, V. corymbosum, V. stamineum* var. *melanocarpum, V. ashei, V. tenellum* and *V. virgatum*.
Distribution: United States (Arkansas, California, Florida, Georgia - Type, Illinois, Mississippi, North Carolina, South Carolina, Texas).

Etymology: *vaccinii* = Latin, (on *Vaccinium*), for the host genus.
Comments: Boyd (1934) studied the ascomal ontogeny of this species and found that it forms a true perithecium with a paraphysate centrum.
References: Boyd, 1934 (Icon); Petrak, 1935; Hanlin, 1990c (Icon).

HOST INDEX

ANACARDIACEAE

Dracontomelon cumingianum Baill.
  O. trichocarpa
Rhus diversiloba Torr. & A. Gray
  O. tarda

ANNONACEAE

Rollinia emarginata Schlecht.
  O. paraguariensis

ASTERACEAE

Tithonia rotundifolia (Mill.) S. F. Blake
  O. tithoniae

BIGNONIACEAE

  O. balansae
  O. bignoniacearum

EHRETIACEAE

Cordia heterophylla Poir.
  O. panamensis

ERICACEAE

Andromeda ferruginea Walt.
  O. ferruginea
Cavendishia sp.
  O. sydowii
Vaccinium arboreum Marsh.
  O. vaccinii
Vaccinium ashei Reade
  O. vaccinii
Vaccinium candicans Michx.
  O. vaccinii
Vaccinium caracasanum H.B.K.
  O. cuervoi
Vaccinium corymbosum L.
  O. vaccinii
Vaccinium stamineum L.
  O. vaccinii
Vaccinium tenellum Aiton
  O. vaccinii
Vaccinium virgatum Aiton
  O. vaccinii

FABACEAE

  O. ulei
Lonchocarpus sp.
  O. atromaculans
Tephrosia elongata E. Mey.
  O. edax
Tephrosia suberosa DC.
  O. edax

MORACEAE

Ficus aurea Nutt.
  O. edax
  O. fici
Ficus carica L.
  O. fici
Ficus jimenezius Standl.
  O. galophila
Ficus sp.
  O. floridanum

MYRSINACEAE

Myrsines sp.
  O. circularis

MYRTACEAE

Eucalyptus goniocalyx F. Muell. ex Miq.
  O. longispora

OCHNACEAE

Ochna pulchra Hook.
  O. liebenbergii

ORCHIDACEAE

Cattleya mossiae Parker
  O. orchidearum
Cattleya sp.
  O. orchidearum
Laelia superbiens Lindl.
  O. orchidearum
Laelia sp.
  O. orchidearum
Odontoglossum uroskinneri Lindl.
  O. orchidearum
Oncidium bicallosum Lindl.
  O. orchidearum
Oncidium cavendishianum Batem.
  O. orchidearum
Oncidium leucochilum Batem.
  O. orchidearum
Oncidium splendidum A. Rich. ex Duch.
  O. orchidearum
Phalaenopsis schillerianum Reichb. f.
  O. orchidearum
Sobralia xantholeuca Hort. ex Williams
  O. orchidearum
Sobralia sp.
  O. orchidearum

PALMAE

  O. palmicola

PLATANACEAE

Platanus occidentalis L.
  O. leucospila

PERIPLOCACEAE

Streptocaulon baumis Decne.
  O. neurophila

FAMILY UNKNOWN

Unidentified plant
  O. leptospora

GEOGRAPHIC DISTRIBUTION OF *OPHIODOTHELLA* SPECIES

AUSTRALIA
- *O. longispora*

BRAZIL
- *O. atromaculans*
- *O. balansiae*
- *O. bignoniacearum*
- *O. circularis*
- *O. leptospora*
- *O. orchidearum*
- *O. ulei*

COLOMBIA
- *O. cuervoi*
- *O. orchidearum*

COSTA RICA
- *O. galophila*

ECUADOR
- *O. sydowii*

GUATEMALA
- *O. orchidearum*

GUYANA
- *O. palmicola*

MEXICO
- *O. orchidearum*

PANAMA
- *O. panamensis*

PARAGUAY
- *O. paraguariensis*

PHILIPPINES
- *O. neurophila*
- *O. orchidearum*
- *O. trichocarpa*

PUERTO RICO
- *O. floridana*

SOUTH AFRICA
- *O. edax*
- *O. liebenbergii*

SRI LANKA (CEYLON)
- *O. edax*

UNITED STATES
- *O. ferruginea*
- *O. fici*
- *O. floridana*
- *O. leucospila*
- *O. tarda*
- *O. vaccinii*

VENEZUELA
- *O. orchidearum*
- *O. tithoniae*

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TYPE STUDIES IN THE POLYPORACEAE - 23 SPECIES DESCRIBED BY C.G. LLOYD IN **LENZITES, POLYSTICTUS, PORIA** AND **TRAMETES**

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Abstract. 181 species described by C.G. Lloyd in Lenzites, Polystictus, Poria and Trametes have been reviewed and the type specimens examined. 130 names are synonyms of existing names, 26 are accepted, 15 names are illegitimate being homonyms of older names, the types for 9 names are sterile and two types are lost. The following new combinations are proposed: Skeletocutis biformis, Skeletocutis sensitivus, Climacodon dubitativus and Trametes glabrata.

Keywords. Basidiomycetes, Polyporaceae, C.G. Lloyd.

Introduction. This is the final paper in a series of papers treating the species C. G. Lloyd described in Polyporaceae s. lato. The reader is referred to the two published parts (Ryvarden 1989, 1990) for a general introduction to the series. As in the previous parts I have followed the Index of Stevenson and Cash (1936) which lists all his new names and combinations. In the Index there are references to the place of publication, Lloyd's collection number and other pertinent data concerning the types. To save space, this information is not repeated here although the country from where the species was described, is given after an abbreviated reference to where the name was published. L.M.W. means Lloyd Mycological Writings and the next digit refers to the volume of the bound version followed with a reference to the pertinent page and year.

In this paper the species are treated in the same way as in the Stevenson and Cash Index (1936), i.e. alphabetically according to specific epithet. The names of the accepted species have been written in bold face indicating the taxonomic disposition according to the author's opinion.

When a species is accepted taxonomically, it is cited in the appropriate genus with a reference to a recent description, or the species is described if no modern description seems to exist.

LENZITES

This name is now, according to the changes in the International Code of Botanical Nomenclature, article 76.4, to be treated as masculine. Thus, many familiar specific epithets in the genus have changed their conjugation. However, I have not changed Lloyd's original spelling.

abietis, L. LMW 6:909, 1920. USA
= Trichaptum laricinum (Karst.) Ryv.
albolutea, L. LMW 6:879, 1919. Java, Indonesia.
= Lenzites acutus Berk.
alborepanda, L. LMW 7:1224, 1923. South Africa.
= Trametes elegans (Spreng.:Fr.) Fr.
clelandii, L. LMW 6:887, 1919. Australia.
= Gloeophyllum trabeum (Fr.) Murr.
glabra L. LMW 5:811, 1918. Solomon Islands.
= Trametes elegans (Spreng.:Fr.) Fr.
huensis L. LMW 7:1106, 1922. China.
= Lenzites acutus Berk.
isabellina, L. LMW 7:1156, 1922. Philippine Islands.
= Lenzites betulinus (Fr.) Fr.
ochracea,L. LMW 7:1106, 1922. Brazil.
= Lenzites betulinus (Fr.) Fr.
pertenuis, L. LMW 7:1106, 1922. Philippine Islands.
= Lenzites betulinus (Fr.) Fr.
saepiformis, L. LMW 7:1273, 1924. Honduras.
= Gloeophyllum mexicanum (Mont.) Ryv.
yoshingae, L. LMW 7:1108, 1922. Japan.
= Lenzites vespaceus (Pers.) Ryv.

POLYSTICTUS

adustus, P. LMW. 5:659, 1917. USA.
= Trametes suaveolens (L.:Fr.) Fr.
aequus, P. LMW. 6:933, 1920. Tasmania.
= Trametes versicolor (L.:Fr.) Pil.
affinis-luteus, P. LMW. 7:1239, 1924. Papua.
= Microporus affinis (Blume & Nees:Fr.) Kunt.
affinis-microloma, P. LMW. 7:1239, 1924. Philippine Islands.
= Microporus affinis (Blume & Nees:Fr.) Kunt.
The type collection has not been found. The following collection, determined by Lloyd, is selected as neotype: Philippine Islands, Laguna, Los Banos Falls, Leg. O. Ocfemina Feb. 1919 (BPI - Lloyd collection).
albo-badius, P. LMW. 6:1038, 1921. Malaysia
= **Trametes albobadia** (Lloyd) Corner. For a description, see Corner 1989:66. Macroscopically this species resembles

Datronia caperata (Berk.) Ryv., but has much shorter spores.
albo-regularis, P. LMW. 7:1145, 1922. Japan.
= Trametes pocas (Berk.) Ryv.
albo-vestidus, P. LMW. 7:1192, 1923. Australia.
= Trichaptum biforme (Fr. in Kl.) Ryv.
anomalosus, P. LMW. 6:1007, 1920. Malaysia.
= nomen dubium. The type consists of a few small pieces of a sterile brown pileate species. It is badly contaminated by many foreign spores and bears all indications of being old and dead or treated with some chemical. Its identity is unknown to me and the name should be dropped from consideration.
anomalus, P. LMW 5:651, 1917. Sydney, Australia.
= Trichaptum byssogenum (Jungh.) Ryv.
arenicola, P. LMW. 5:651, 1917. USA
= Coltricia focicola (Berk. & Curt.) Murr.
argenteus, P. LMW. 7:1112, 1922. Zimbabwe.
= Coriolopsis floccosa (Jungh.) Ryv.
ater, P. LMW. 7:1314, 1924. Malaysia.
= Microporellus obovatus (Jungh.) Ryv.
bicolor, P. LMW. 6:1001, 1920. Singapore.
= **Skeletocutis bicolor** (Lloyd) Ryv. comb nov. Basionym as cited above.
Basidiocarp effused reflexed, pileus up to 4 mm wide, smooth, glabrous and pale brown, pore surface pale straw-coloured, pores small and angular, 6-7 per mm, margin white in parts cobwebby and 2-4 mm wide, tubes fragile concolorous with pore surface, 200 um deep, subiculum white cottony, less than 5o um thick.
Hyphal system dimitic, generative hyphae with clamps, hyaline and 2-4 um wide, skeletal solid to thick-walled, hyaline and in parts densely covered with crystals, especially in the dissepiments, cystidia not seen, basidiospores globose, hyaline, thin-walled and IKI-, 2.5-3 um in diameter. Known only from the type locality.
The dimitic hyphal system with clamped generative hyphae and encrusted skeletal hyphae and small spores, place this species in Skeletocutis as circumscribed in moderns floras.
conglomerus, P. LMW. 5:706, 1917.USA
= Trametes versicolor (L.:Fr.) Pil.
cuneato-brunneus, P. LMW 6:1005, 1917. Philippines.
= The type is lost.
decurrens, P. LMW. 3:12, 1908. USA
= Coltricia perennis (L.:Fr.) Murr.
doidgei, P. LMW. 7:1329, 1924. South Africa
= Trametes versicolor (L.:Fr.) Pil.
dubitativus, P. LMW. 7:1111, 1922. Philippine Islands.
= **Climacodon dubitativus** (Lloyd) Ryv. comb nov. Basionym as

cited above.

This species was later described by Maas Geesteranus (1971:135) as Climacodon efflorescens. The reader is referred to his detailed descriptions and illustrations.

eburneus, P. LMW 7:1331, 1924. Malaysia.
= The type is lost.

felipponei, P. LMW. 5:842, 1919. Uruguay
= Datronia caperata (Berk.) Ryv.

ferruginosus, P. LMW. 7:1242, 1924. Indonesia.
= Coltricia cinnamomea

flabellaris, P. LMW. 7:1316, 1924. Philippine Islands.
= Trametes menziesii (Berk.) Ryv.

flexibilis, P. LMW. 7:1111, 1922. Brazil
= Coriolopsis cf. telfarii (Kl.) Ryv. The type is sterile and there is of course a possibility that the American taxon has spores different from that of the paleotropics. C. telfarii was originally described on basis of a collection from Mauritius in the Indian Ocean.

formosae, P. LMW. 5:632, 1917. Taiwan.
= Earliella scabrosa (Pers.) Gilbn. & Ryv.

fusco-zonatus, P. LMW. 5:69, 1919. West Africa.
= Coriolopsis asper (Jungh.) Teng.

gilvocolor, P. LMW. 7:1239, 1924. Indonesia.
= Coriolopsis sanguinaria (Kl.) Ryv.

glabratus, P. LMW. 5:626, 1917. Japan.
= **Trametes glabrata** (Lloyd) Ryv. comb. nov. Basionym: Polystictus glabratus Lloyd, Lloyd Mycol. Writ. 5:626, 1917.

Basidiocarps annual, fanshaped to spatulate, up to 3 cm wide and long tapering to a semi-stipitate base, 1-4 mm in diameter, coriaceous when fresh, fragile when dry, upper surface glabrous, faintly zonate and somewhat radially furrowed in dry specimens, probably smooth when fresh, white when fresh, in the type ochraceous to wood-coloured, pore surface concolorous, uneven and larger pores subdivided into smaller, thin-walled and angular, approximately 2-3 per mm, context thin, whitish.

Hyphal system trimitic, generative hyphae with clamps, 2-4 um wide, skeletal hyphae thick-walled to solid, hyaline, 3-5 um wide, binding hyphae solid, tortuous, 1-3 um wide, cystidia and basidia not seen, basidiospores allantoid, hyaline and negative in Melzers reagent, 1-1.5 x 4-5 um.

Macroscopically this species is very similar to Trametes membrancea (Fr.) Kreisel from America, which however have wider and longer spores besides much smaller pores. It also resembles old glabrous specimens of Trichaptum biforme which have similar macroscopical characters. However, it is easily separated by having much larger spores and abundant cystidia

in the hymenium.
The whitish fanshaped basidiocarps with angular pores should make this species easy to recognize in the field.

glabro-rigens, P. LMW. 7:1145, 1922. Borneo.
= Coriolopsis sanguinaria (Kl.) Ryv.
glauco-effusus, P. LMW. 7:1152, 1922. South Africa.
= Coriolopsis floccosa (Jungh.) Ryv.
glaucoporus, P. LMW. 7:1334, 1925. Zimbabwe.
= Coriolopsis floccosa (Jungh.) Ryv.
hexagonoides, P. LMW. 5:820, 1919. Brazil.
= Datronia cf. stereoides (Fr.) Ryv. The type is sterile and badly developed, but macroscopically it may represent and old and dead specimen of this species.
houstonii, P. LMW. 6:897, 1919.USA.
= Phylloporia chrysita (Berk.) Ryv.
hunteri, P. LMW. 7:1315, 1924. Ghana.
= Trametes menziesii Berk.) Ryv.
hutchingsii, P. LMW. 7:1316, 1924 India.
= Trametes menziesii (Berk.) Ryv.
imbricatus, P. LMW. 5:791, 1918. Australia.
= Trametes membranacea (Sw.:Fr.) Kreisel
immaculatus, P. LMW. 7:1110, 1922. Ecuador.
= Trametes sp. sterile and badly developed.
incisus, P. LMW. 7:1155, 1922. Philippine Islands.
= Microporellus obovatus (Jungh.) Ryv.
lamii, P. LMW. 7:1240, 1924. Indonesia.
= Trametes menziesii (Berk.) Ryv.
lavendulus, P. LMW. 7:1121, 1922. USA.
= Trichaptum biforme (Fr. in Kl.) Ryv.
lignicola, P. LMW. 5:696, 1917. Brazil.
= Amauroderma sp., an immature and sterile specimen.
luteo-affinis, P. LMW. 6:1001, 1920. Angola.
= Microporus affinis (Blume & Nees:Fr.) Kunt.
macuonii, P. LMW. 4:53, 1914. Canada.
= Trametes versicolor (L.:Fr.) Pil.
minutoporus, P. LMW. 7:1317, 1924. Japan.
= Trametes versicolor (L.:Fr.) Pil.
oblectabilis, P. LMW. 3: 164, 1912. Brazil.
= **Coltricia oblectabilis** (Lloyd) Ryv. For a description, see Ryvarden & Johansen 1980.
oblivionis, P. LMW. 3:164, 1912. Brazil.
= Coltricia hamata (Rom.) Ryv.
ochraceo-stuppeus, P. LMW. 5:63, 1916. Australia.
= Bjerkandera adusta (Fr.) Karst.
ochrohirsutus, P. LMW. 7:1233, 1923. Japan.
= Trametes hirsuta (Fr.) Pil.
ochrotenuis, P. LMW. 7:1318, 1924.Malaysia.

= Trametes menziesii (Berk.) Ryv.
pallidus, P. LMW. 7:1006, 1920. Malaysia.
= Microporus microloma (Lév.) Kunt.
This is a species related to M. affinis and mainly separated by a much paler pileus and more allantoid spores, i.e. 4.5-5 x 1.2 um (M. affinis: 3-4 x 1.5-2 from African sporeprint).
proliferus, P. LMW. 3:8, 1908. Ohio.
= Coltricia perennis (L.:Fr.) Murr.
prosector, P. LMW. 7:1147, 1922. China
= Trichaptum biforme (Fr.) Ryv,
pseudoperennis, P. LMW. 3:53, 1910. Philippine Islands.
= Microporus affinis (Blume & Nees:Fr.) Kunt.
purus, P. LMW. 7:1158, 1922. Indonesia.
= Trametes marianna (Pers.) Ryv.
rarus, P. LMW. 6:997, 1920. USA.
= Trametes conchifer (Schw.:Fr.) Pil.
roseoporus, P. LMW. 7:1331, 1924. Malaysia.
= Microporus affinis (Blume & Nees:Fr.) Kunt.
rufo-rigidus, P. LMW. 7:1330. 1924. Australia.
= Polyporus grammocephalus Berk.
scopulosus, P. LMW. 5:843, 1919. Japan.
= Microporus microloma (Lév.) Kunt.
sebesiei, P. LMW. 7:1240, 1924. Indonesia
= Microporus microloma (Lév.) Kunt.
semiincrustans, P. LMW. 7:1236, 1923. USA.
= Trichaptum abietinum (Fr.) Ryv.
semisanguineus, P. LMW. 4:39, 1912. Singapore.
= Pycnoporus puniceus (Fr.) Ryv.
sepia, P. LMW. 7:1155, 1922. Philippine Islands.
= Microporus xanthopus (Beauv.: Fr.) Kunt.
similis, P. LMW. 7:1159, 1922. Indonesia
= Earliella scabrosa (Pers.) Gilbn. & Ryv., a badly developed specimen.
striatulus, P. LMW. 6:890, 1919. Philippine Islands.
= Microporus microloma (Lév.) Kunt.
subaffinis, P. LMW. 4:550, 1916. Japan.
= Microporus microloma (Lév.) Kunt.
subcaperatus, P. LMW. 6:996, 1920. Australia
= Datronia daedaleoides (Berk.) Ryv.
subiculoides P. LMW. 7:1331, 1924. South Africa.
= Schizopora flavipora (Cooke) Ryv.
subochraceus, P. LMW 7:1191, 1923. Brazil.
= Trametes cotonea (Pat. & Har.) Ryv.
subpictus, P. LMW. 4:43, 1912. Japan.
= Coltricia cinnamomea (Pers.) Murr. infected by an imperfect fungus.

subreflexus, P. LMW. 6:884, 1919. Philippine Islands.
= Protomerulius substuppeus (Berk. & Curt.) Ryv.
tenuiculus, P. LMW. 7:1155, 1922. Sri Lanka.
= Polyporus philippinensis Berk.
turgidus, P. LMW. 7:1193, 1923. Borneo.
= Mollicarpus cognatus (Berk.) Ginns.
xantho-concinnus, P. LMW 5:618, 1916. South Africa.
= **Podoscypha xantho-concinna** (Lloyd) Reid.
For a description, see Reid 1975:80.

PORIA

cylindrospora, P. LMW. 5:65, 1917. USA.
= Phellinus ferreus
orchidaceae, P. LMW 7:1241, 1924. Indonesia.
= Sterile and infected.
pulvinata, P. LMW. 7:1196, 1923. Zaire.
= Loweporus inflexibilis (Berk.) Ryv.
xylina,P. LMW 5:630, 1917. Japan.
= Leucophellinus irpicoides (Pil.) Bond.

TRAMETES

albotexta, T. LMW. 5:614, 1916.
= **Ischnoderma albotexta** (Lloyd) Reid.
For a description, see Reid 1975.
borneoensis, T. LMW. 7:1113, 1922. Sarawak
= Coriolopsis sp. The type is sterile. It may represent a prior name for one of the many species in Trametes (s. lato) recently described by Corner from South-East Asia (Corner 1989).
brunneo-flava, T. LMW 7:1113. Costa Rica
= Trametes cubensis (Mont.) Sacc.
farcta, T. LMW. 4:?, 1915. Brazil.
= Phellinus viticola (Schw.) Donk
gilvoides, T. LMW. 4:520, 1912. USA.
= Phellinus viticola (Schw.) Donk
guatemalensis, T. LMW. 6:1091, 1921. Guatemala.
= Trametes elegans (Spreng.:Fr.) Fr.
karii, T. LMW. 7:1148, 1922. India.
= Trametes lactinea Berk.
krekei, T. LMW. 5:69, 1919. USA
= Spongipellis delectans (Pk.) Murr.
lacerata, T. LMW. 5:604, 1916. USA
= Irpex lacteus Fr.
morganii, T. LMW. 5:69, 1919. USA
= Antrodia serialis (Fr.) Donk.
nigroaspera, T. LMW. 7:1272, 1924. Japan.
= Daedaleopsis confragosa (Bolt.: Fr.) Schroet.
nigro-plebeia, T. LMW. 7:1113, 1922. Sarawak.

= Fomitopsis dochmius (Berk.) Ryv.

obscurotexta, T. LMW. 7:1271, 1924. Angola.

= Coriolopsis floccosa (Jungh.) Ryv.

ochrolignea, T. LMW. 5:63, 1916. South Africa.

= Coriolopsis polyzona (Pers.) Ryv.

pusilla, T. LMW. 5:774, 1918. USA.

= Trametes pubescens (Fr.) Pilat.

quercina, T. LMW. 7:1114, 1922. USA.

= Trametes pubescens (Fr.) Pilat.

retropicta, T. LMW. 7:1113, 1922. Malaysia.

= Coriolopsis sanguinaria (Kl.) Teng.

roseoporus, T. LMW. 7:1116, 1922. Brazil.

= Loweporus roseo-albus (Jungh.) Ryv.

roseo-zonata, T. LMW. 7:1144, 1922. Japan.

= Fomitopsis cajanderi (Karst.) Kotl. & Pouz.

rufescens, T. LMW. 5:69, 1919. USA.

= Trametes cubensis (Mont.) Sacc.

rugoso-picta, T. LMW. 6:1039, 1921. Ecuador.

= Trametes cubensis (Mont.) Sacc.

sensitiva, T. LMW. 5:710, 1917. Japan.

= **Skeletocutis sensitiva** (Lloyd) Ryv. comb. nov. Basionym: Trametes sensitiva Lloyd, Lloyd Mycol. Writ. 5:710, 1917.

Basidiocarp effused reflexed to resupinate,adnate and tough when dry, up to 10 cm in diameter in effused specimens, up to 10 mm thick, pileus usually narrow, 1 cm wide, smooth, glabrous, margin lifted in dry specimens, distinct and rounded, pore surface cream to beige with a slight rosy tint, pores round 4-5 per mm, tubes concolorous, context white and very thin.

Hyphal system di to trimitic, generative hyphae with clamps, 2-3 um in diameter, skeletal hyphae dominating, solid, hyaline, 3-4 um in diameter, in the dissepiments heavily encrusted with fine grainy crystals, a few sparingly branched binding hyphae observed, solid and hyaline, 2-3 um wide.

Basidia and cystidia not seen, basidiospores ellipsoid, smooth, thin-walled, negative in Melzers reagent, difficult to observe in most specimens, 3-3.5 x 4-4.5 um.

Causes a white rot in hardwoods. Widespread in Japan.

The species is placed in Skeletocutis because of the hyphal structure with encrusted skeletal hyphae, the small hyaline spores and the white rot.

stowardii, T. LMW. 5:683, 1917. Australia.

= Trametes lilacino-gilvus Berk.

subflava, T. LMW. 5:66, 1917. South Africa.

= **Oxyporus subflava** (Lloyd) Reid.

For a description, see Reid 1973.

subminima, T. LMW. 6:1060, 1921. Australia.

= Trametes sp. The type is sterile and immature.

sulcata, T. LMW. 7:1146, 1922. Brazil.
= **Navisporus sulcatus** (Lloyd) Ryv.
For a description, see Gilbertson & Ryvarden 1987:451.

tenuo-rosea, T. LMW. 7:1193, 1923. Malaysia.
= Fomitopsis feeii (Fr.) Kreisel.

transmutans, T. LMW. 6:996, 1920. Singapore.
= Lenzites acutus Berk.

truncata, T. LMW. 7:1156, 1922. Philippine Islands.
= **Perenniporia truncata** (Lloyd) Ryv.

Basidiocarps pileate, sessile, effused, reflexed, individual pilei small imbricate, up to 2 cm wide and 4 cm long along the substrate, pilei triquetrous in section, up to 1 cm thick at the base, woody, upper surface glabrous, warted to scrupose, black at the base, olivaceous towards the margin, margin along effused part narrow and black, pore surface ochraceous to pale dirty brown, pores round and entire on horizontal parts, 3-4 per mm, elongated and partly sinuous on sloping parts, tubes concolorous, up to 8 mm deep, context dense, ochraceous, up to 4 mm thick.

Hyphal system trimitic, generative hyphae with clamps, 2-3 um wide, binding hyphae of the Bovista type, arboriform, solid to thick-walled, slightly dextrinoid, 3-6 um wide, cystidia and basidia not seen, basidiospores truncate, subglobose, thick-walled, slightly dextrinoid, 6-7.5 x 4.5-5.5 um.

This is a highly characteristic species with the partly black pileus and the strongly branched arboriform binding hyphae. The spores are close to those seen in Perenniporia medulla-panis (Fr.) Donk, which however is a strictly resupinate species and with rather narrow, and non-dextrinoid, sparingly branched skeletal hyphae.

truncatospora, T. LMW. 5:853, 1919. Japan.
= **Perenniporia truncatospora** (Lloyd) Ryv.
For a description, see Ryvarden, Liang-Wang, Ji-ding 1986:228.

varia, T. LMW. 7:1114, 1922. Australia.
= Polyporus fusco-lineatus Berk. & Broome.

violacea, T. LMW. 4:342, 1915. South Africa.
= Nigroporus vinosus (Berk.) Murr.

vitrea, T. LMW. 5:69, 1919. Singapore.
= Fomitopsis feeii (Fr.) Kreisel.

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I am grateful to Dr. T. Niemelä of the Helsinki University, Finland, who has critically read the manuscript and suggested improvements. I also express my thanks to Dr. T. Hattori of the Forest and Forestry Products Research Institute, Tsukuba, Japan who has supplied recent collections of Trametes sensitiva Lloyd.

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REDISPOSITION OF APOSPHAERIA AMARANTHI IN MICROSPHAEROPSIS[1]

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ABSTRACT

Isolates of *Aposphaeria amaranthi* Ell. & Barth., from *Amaranthus* species, are compared with the type species of the genus, *Aposphaeria pulviscula* (Sacc.) Sacc., and with *Phoma betae* Frank, *Phoma herbarum* Westd., *Microsphaeropsis centaureae* Morgan-Jones, and *Microsphaeropsis olivacea* (Bonorden) Höhnel. *Aposphaeria amaranthi* is reclassified in the genus *Microsphaeropsis* and renamed *Microsphaeropsis amaranthi* (Ell.& Barth.) Heiny & Mintz with a complete description.

INTRODUCTION

The genus *Aposphaeria* Sacc. includes approximately 200 species (Sutton, 1980), most of which grow on woody plants. Many of the species included are poorly described and may not be congeneric with the type, *Aposphaeria pulviscula* (Sacc.) Sacc. (Saccardo, 1880). Thaxter (1922) and Sprague (1962) both commented on the need for a revisionary treatment, but many *Aposphaeria* species must be studied in greater detail to facilitate any future revision.

In September 1987, a fungus (isolate #843; IMI #327754) was isolated from a diseased *Amaranthus* species (pigweed), collected by A. S. Mintz at the University of Arkansas

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Agricultural Experiment Station Farm, Fayetteville, Arkansas, and was subsequently determined to have potential as a biocontrol agent on pigweed species, especially *Amaranthus albus* L. (Mintz, 1991; Mintz *et al.*, 1992). The fungus was identified as *Aposphaeria amaranthi* Ell. & Barth., previously collected in Rooks County, Kansas, June 21, 1895, on dead stems of *Amaranthus retroflexus* L. (Ellis and Bartholomew, 1896). The type specimen of *A. amaranthi* from the Bartholomew collection was loaned to us by the Farlow Herbarium (FH) of Harvard University, Cambridge, Massachusetts. To our knowledge, *A. amaranthi* has not been discussed in the literature since Saccardo (1899) listed the species with a Latin description, and no illustrations exist in the literature. *Aposphaeria amaranthi* was probably assigned to the genus initially because its pycnidia are superficial on plant tissue, a criterion employed to distinguish some pycnidial fungi from *Phoma* and *Phyllosticta* (Sprague, 1962). Modern taxonomic standards for distinguishing *Phoma* species are based on morphological and cultural characteristics (Sutton, 1980). We believe that *A. amaranthi* closely matches the characteristics of *Phoma* species, a heterogeneous group, but is more appropriately classified in *Microsphaeropsis*. In this report we present a comparison of our *A. amaranthi* isolates to the type collected nearly a century earlier, and propose a new name combination for the species.

MATERIALS AND METHODS

Two isolates of *A. amaranthi* (private collection #843 and #969) were used to demonstrate variation within the species. Other cultures studied included *Phoma betae* Frank (ATCC #24635) (Boerema and Dorenbosch, 1973), *Phoma herbarum* Westd. (ATCC #12569), the type species of the genus (Morgan-Jones, 1988), *Microsphaeropsis centaureae* Morgan-Jones (ATCC #32058), and *Microsphaeropsis olivacea* (Bonorden) Höhnel (ATCC #62198), the type species for the genus. Cultures of the *A. amaranthi* isolates were grown on three replicate plates of each of five media at 20 or 25°C with 12 hours of fluorescent light each day (General Electric Cool White, lighted incubator Model 1-35VL, Percival Mfg. Co., Boone, IA) or in darkness in ventilated black boxes in the same incubator. The media included the following: oatmeal agar (Difco Laboratories), prepared one-half strength, replacing the agar; potato dextrose agar (Difco Laboratories), acidified with four to five drops of 25% lactic acid per 100 ml of melted media (Tuite, 1969); malt extract agar (Difco Laboratories); cellulose agar (Eggins and Pugh, 1962), substituting Sigmacell Type 20 microcrystalline cellulose (Sigma Chemical Company) for cotton cellulose powder (Morgan-Jones and White, 1983) and doubling the agar; and pea juice agar (Weidemann *et al*., 1988) using only 18 g agar per liter. Agar disks, 5 mm in diameter, were taken from 7-day-old oatmeal agar spread plate cultures and inverted in the center of each plate. Colony characteristics and radial growth rates were observed at 7 and 14 days. Lesions on stems of *Amaranthus albus* inoculated with conidia of *A. amaranthi* were surface-sterilized and incubated as above in a humid chamber for 7 to 10 days to promote pycnidial development. Pycnidia from oatmeal agar cultures were also air-dried for comparison to the dried type specimen of *A. amaranthi*. Dried specimens of *A. pulviscula* (#1546, #1299) were obtained from the Royal Botanic Gardens at Kew, England, and dried specimens of *P. betae* (IMI 70665, 193078, 297878) were loaned from the International Mycological Institute, England. Pycnidia were fixed in Karnovsky's fixative (Karnovsky, 1965), embedded in JB-4 resin (Polysciences, Inc., Warrington, PA), sectioned with a glass knife, stained with Lugol's iodine (Tuite, 1969) followed by 1% aniline blue in 90% ethanol, washed, and mounted in Plastic Mount Mounting Media (Polysciences, Inc.).

Dimensions of at least 15 conidia and pycnidia mounted in lactophenol were measured from cultures grown in light as described above at 25°C on oatmeal agar for each isolate of *A. amaranthi*. Agar blocks of cultures were exposed to ammonia vapors or treated with 1 N NaOH for observation of pigment change, a defining characteristic for some *Phoma* species (Dorenbosch, 1970). To study conidial germination, conidia diluted in water were spread over a washed cellulose membrane on 1.5% water agar and incubated at 20 or 25°C with light for intervals as indicated in the figures.

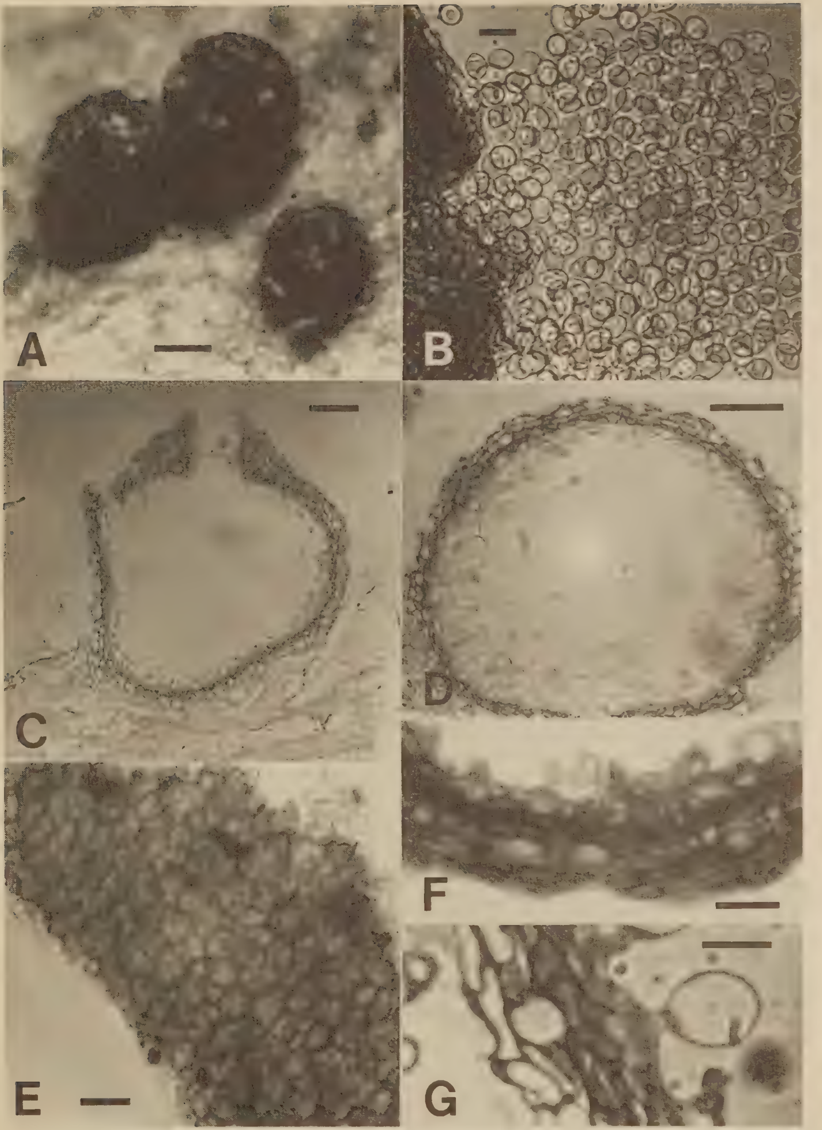
RESULTS AND DISCUSSION

Morphological characteristics of isolate #843, which were similar to characteristics of #969, closely matched those of the type of *A. amaranthi* (Figs. 1, 2). Dried pycnidial cells of #843 (Fig. 2) were more similar to the pycnidial cells from the *A. amaranthi* type specimen (Fig. 1) than cells from fresh pycnidia of #843. Slight differences in the appearance of pycnidial walls of isolate #843 compared to the type of *A. amaranthi* were probably due to differences in maturity and melanization dependent on substrate and environment, since the type specimen was preserved on mature, dead pigweed stems collected in nature. Relative hydration at the time of fixation was also a factor in cell appearance (Figs. 1, 2).

The morphology of *A. amaranthi* differs from the type, *A. pulviscula* (Sutton, 1980), in several respects. Conidiophores, which are branched and septate in *A. pulviscula*, are absent in *A. amaranthi* and are replaced by phialidic conidiogenous cells. The outer pycnidial wall is more organized and smooth in *A. amaranthi*, the inner layer of hyaline cells is not pronounced, and the inner-layer cell size is not substantially different from the outer-layer cell size (Figs. 1, 2). In contrast, the inner layer of the pycnidial wall of *A. pulviscula* has distinctly smaller cells than the outer layer (Fig. 3; Sutton, 1980). The hyaline conidia of *A. pulviscula* are nearly cylindrical, whereas conidia of *A. amaranthi* are oval or almost spherical. Because we were unable to obtain living cultures of *A. pulviscula* and published accounts are incomplete, we cannot comment on spore color in mass for this species. However, cultures of other species of *Aposphaeria* reportedly produce yellowish cream-colored masses of conidia (Chesters, 1938).

Dennis (1946) first noted the need for comparison of *Phoma*-like species under uniform conditions on artificial media and began the tradition, followed by subsequent authorities (Boerema and Dorenbosch, 1973; Morgan-Jones and White, 1983), of publishing photographs of colonies on media. Oatmeal agar and malt extract agar were favored by Boerema for study of *Phoma*-like species, while Morgan-Jones routinely used potato dextrose agar, malt extract agar and cellulose agar at 20 and 25°C for cultural

FIGURE 1. *Aposphaeria amaranthi* type specimen. A. Pycnidia on pigweed stem. Bar = 100 μm. B. Conidia mounted in lactophenol. Bar = 20 μm. C. Longitudinal section of pycnidium on pigweed stem. Bar = 50 μm. D. Section of pycnidium. Bar = 50 μm. E. Textura angularis in pycnidial wall. Bar = 20 μm. F. Cross section of pycnidial wall revealing conidiogenous cell layer. Bar = 20 μm. G. Conidiogenous cell and developing conidium. Bar = 10 μm.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comparisons. In this paper, pea juice agar was included because it promoted abundant sporulation (Table 1).

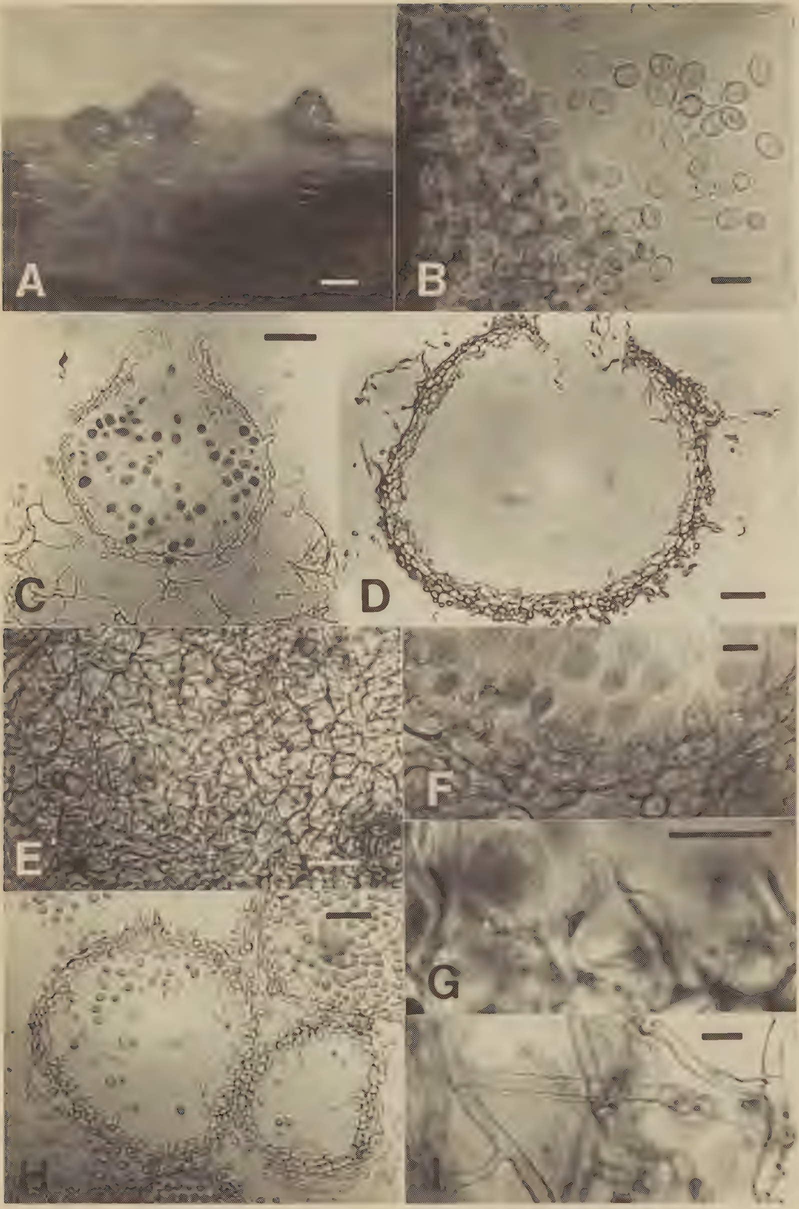
Aposphaeria amaranthi sporulated on several media in 5 to 9 days. Colonies generally grew faster at 25°C than at 20°C (Table 1) and varied in appearance on different media (Fig. 4). Cultures of *A. amaranthi* were similar in pigmentation and general appearance to cultures of *P. betae*, especially on oatmeal agar (Fig. 5) and pea juice agar, but *P. betae* conidia in mass remained beige or pastel orange rather than darkening to buff or green as observed for *A. amaranthi* (Table 2). Exposure to light generally increased pigmentation. *Microsphaeropsis centaureae* developed slowly at 25°C (Fig. 5). However, after 2 weeks on oatmeal agar at 23°C, *M. centaureae* cultures were similar in appearance to *A. amaranthi* cultures, except that conidia in mass were much darker in *M. centaureae* cultures.

The two isolates of *A. amaranthi* differed slightly in appearance on the various media (Table 2). Isolate #843 cultures frequently sectored or developed with uneven margins or at different rates.

Overall, conidia of isolate #969 were slightly smaller than conidia of isolate #843 (Table 2). *Phoma amaranthi* Brun. and *Phoma amaranthicola* Brun. were previously listed on *Amaranthus albus* and *Amaranthus spinosus* L., respectively (Saccardo, 1895). Conidial dimensions for *P. amaranthi* (7-8 × 3 μm) and *P. amaranthicola* (2-3 × 1.5-2 μm) eliminate any possibility of either of these being conspecific with *A. amaranthi*. Conidia of *A. amaranthi* were similar in shape to conidia of *P. betae*, *M. olivacea*, and *M. centaureae*, but were distinctly larger (Fig. 6).

As described for *P. betae* (Booth and Cornford, 1959), conidia of *A. amaranthi* often germinated by first forming a subglobose vesicle that later produced a germ tube or a second vesicle (Fig. 6). Sometimes a septum developed

FIGURE 2. Isolate #843. A. Pycnidia developing on pigweed stem. Bar = 100 μm. B. Conidia mounted in lactophenol. Bar = 20 μm. C. Longitudinal section through pycnidium on pigweed stem. Bar = 50 μm. D. Section of air-dried pycnidium from oatmeal agar. Bar = 50 μm. E. Textura angularis in pycnidial wall. Bar = 20 μm. F. Cross section of pycnidial wall. Bar = 10 μm. G. Conidiogenous cell. Bar = 10 μm. H. Section of pycnidia from culture. Bar = 50 μm. I. Hyphae from culture. Bar = 10 μm.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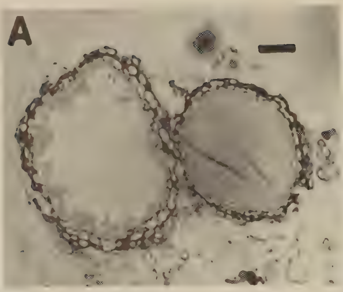


FIGURE 3.
A. Section through *Aposphaeria pulviscula* pycnidia. Bar = 20 µm.

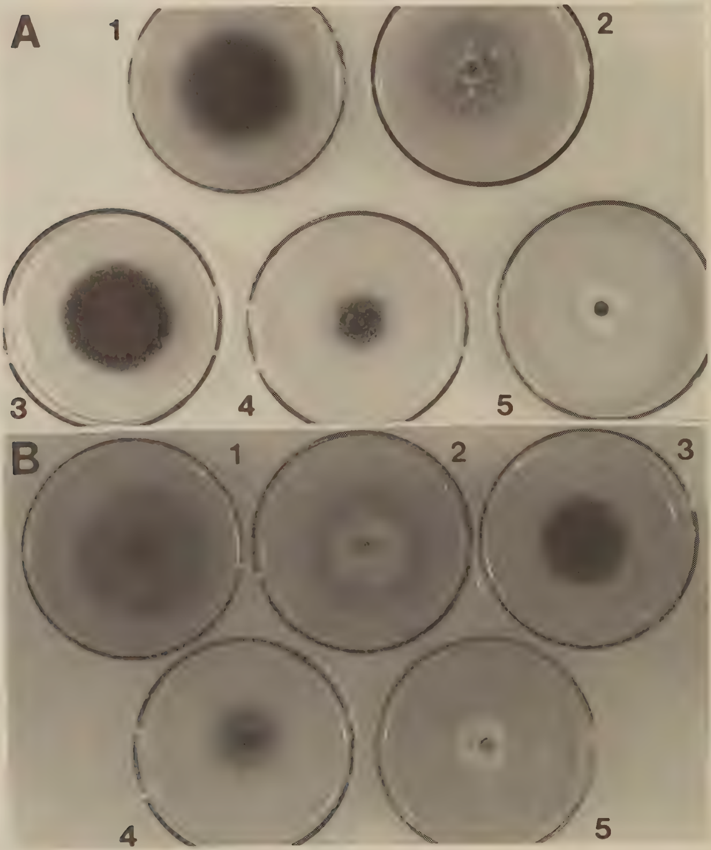


FIGURE 4. A, B. Isolate #969 incubated in darkness for 7 days at 20°C (A) and 25°C (B). 1. Oatmeal agar. 2. Pea juice agar. 3. Potato dextrose agar. 4. Malt extract agar. 5. Cellulose agar.

TABLE 1

Mean colony diameters of two *Aposphaeria amaranthi* isolates at 20 or 25°C in darkness or with 12 hours of light per day.

		Oatmeal Agar[a]		Malt Extract Agar[a]		Potato Dextrose Agar[a]		Cellulose Agar[b]		Pea Juice Agar[c]	
		light (cm)	dark (cm)	light (cm)	dark (cm)	light (cm)	dark (cm)	light (cm)	dark (cm)	light (cm)	dark (cm)
20℃											
Isolate #969	1 wk	5.2	4.5	3.0	2.7	4.9	4.9	2.6[d]	2.4[d]	3.7	3.4
	2 wk	9.0	8.8	5.6	5.6	8.8	8.5	6.3[d]	4.1[d]	6.5	6.0
Isolate #843	1 wk	3.2	2.2[d]	2.2	1.7[d]	2.5	2.1[d]	0.9[d]	1.8[d]	3.2[d]	3.5[d]
	2 wk	3.4	4.0[d]	4.8	3.1[d]	5.9	5.5[d]	1.5[d]	2.0[d]	5.4[d]	5.8
25℃											
Isolate #969	1 wk	5.7	5.5	3.9	3.3	5.1	4.9	2.2	3.1[d]	4.3	4.3
	2 wk	9.0	9.0	7.0	6.4	7.4	8.5	6.1	6.9[d]	7.7	7.7
Isolate #843	1 wk	2.5	2.5	2.0	1.7[d]	2.8	1.8[d]	0.6[d]	0.8[d]	3.1	3.0[d]
	2 wk	5.8	4.9	4.9	2.2[d]	6.3	4.8[d]	1.4[d]	2.2[d]	6.2	5.6[d]

[a] Difco Laboratories, Detroit, MI 48232. Oatmeal agar prepared one-half strength and agar replaced. Potato dextrose agar acidified with lactic acid (Tuite, 1969).

[b] Eggins and Pugh (1962), substituting Sigmacell Type 20 microcrystalline cellulose (Sigma Chemical Company, St. Louis, MO) for ball-milled Whatman's cotton cellulose powder and doubling the agar.

[c] 400 ml of liquid from commercial, salt-free, canned peas, and 18 g agar per liter of medium (modified recipe of Weidemann et al., 1988).

[d] No sporulation.

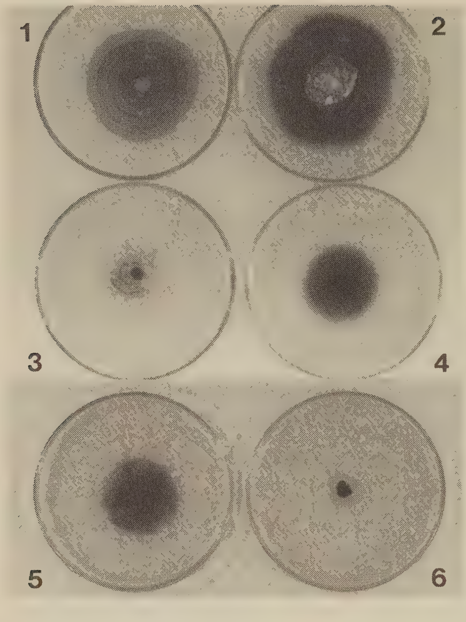


FIGURE 5. Cultures on oatmeal agar incubated in light at 25°C for 7 days.

1. *Phoma betae.*
2. Isolate #969.
3. Isolate #843.
4. *Phoma herbarum.*
5. *Microsphaeropsis olivacea.*
6. *Microsphaeropsis centaureae.*

within the conidium during or following germination, and germ tubes were septate. *P. herbarum* also produced a vesicle similar to the conidium in size and shape prior to germ tube formation (Fig. 6). However, conidia of *M. olivacea*, and, less frequently, *M. centaureae* produced vesicles in the same manner, so the process suggests similarities rather than differences between the two genera. Conidia of *M. centaureae* typically did not germinate on the cellulose membrane, but germinated on agar media.

Conidia and hyphal strands of *A. amaranthi* produced fusion pegs with each other and with hyphae. Brown extracellular deposits were produced in older cultures of isolates #843 and #969, especially on hyphae immersed in malt extract agar or pea juice agar (Fig. 7). Extracellular deposits were not observed in cultures of the other species in the study. Isolates #843 and #969 also produced occasional intercalary chlamydospore-like cells within hyphae immersed in media (Fig. 7).

The thin-walled pycnidia, lack of conidiophores, and phialidic conidiogenous cells of *A. amaranthi* suggest closer affiliation with *Phoma* or *Microsphaeropsis* species

TABLE 2

Cultural and morphological characteristics of two *Aposphaeria amaranthi* isolates.

	Pycnidia Diameter[a] (μm)	Range (μm)	Conidia Dimensions[a] (μm)	Range (μm)	Colony Pigment (25°C, Darkness)[b]	Spore Color in Mass	Ammonia or NaOH Effect on Pigment in Agar
Isolate #969	273	200-400	12.6 × 11.3	8.0-15.9 × 8.0-11.8	yellowish olive green	beige, becoming greenish with age on oatmeal agar	changes from mustard to red, then dark brown
Isolate #843	351	140-480	15.4 × 12.2	10.2-22.0 × 9.1-15.6	white to pale pastel orange on pea juice agar or at 20°C; gray to olive green on other media	beige to yellow; pale buff on pea juice agar	changes from colorless to yellow or pale brown

[a] Average of fifteen.
[b] Pigment intensifies when cultures are grown in light.

than with *A. pulviscula*. The relatively large pycnidia (133-567 µm) and broad conidia (Byford and Gambogi, 1985) of *P. betae* suggest relatedness with *A. amaranthi*. Conidia of *Phoma capitulum* Pawar, Mathur & Thirum. are also subglobose to ellipsoid (Sutton, 1980). *Aposphaeria*

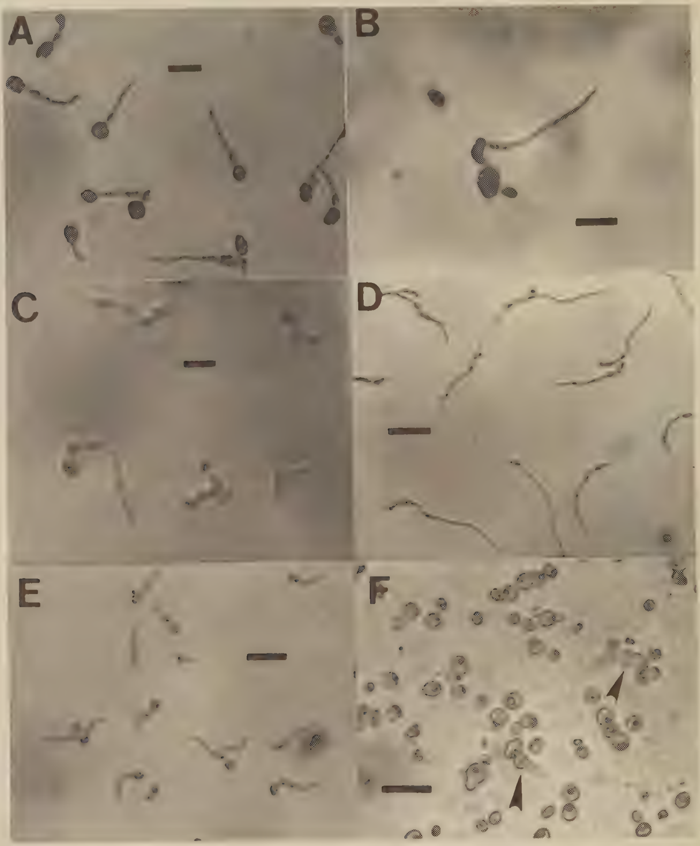


FIGURE 6. Germination of conidia. A-E: Conidia and hyphae incubated on cellulose membrane over water agar, stained with lactophenol cotton blue. A. Isolate #969, 5 hours, 25°C. Bar = 20 µm. B. Isolate #843, 8 hours, 20°C. Bar = 20 µm. C. *Phoma betae*, 8 hours, 20°C. Bar = 10 µm. D. *Phoma herbarum*, 8 hours, 20°C. Bar = 20 µm. E. *Microsphaeropsis olivacea*, 29 hours, 25°C. Bar = 20 µm. F. *Microsphaeropsis centaureae*, 18 hours, 23°C, unstained on potato dextrose agar. Bar = 20 µm.

amaranthi also shares characteristics with *Microsphaeropsis*, another genus undergoing revision (Morgan-Jones and White, 1987). Pycnidial fungi with small, pigmented, unicellular conidia produced from phialides are classified in *Microsphaeropsis* (Morgan-Jones, 1974). Conidia of *A. amaranthi* appear hyaline and lack the dark pigmentation of species such as *Microsphaeropsis concentrica* (Desm.) Morgan-Jones, which produces conidiomata that exude blackish conidial masses (Morgan-Jones and White, 1987). However, the conidia of *A. amaranthi* appear to have slightly thickened walls with a yellowish pigmentation. The pale green pigmentation in mass indicates greater similarity to *Microsphaeropsis* than to *Phoma*. *Microsphaeropsis centaureae*, for example, has conidia described as pale brown to yellowish-brown (Morgan-Jones, 1974). The conidia of many *Microsphaeropsis* species have surface ornamentation, but the type, *M. olivacea*, produces conidia with smooth walls

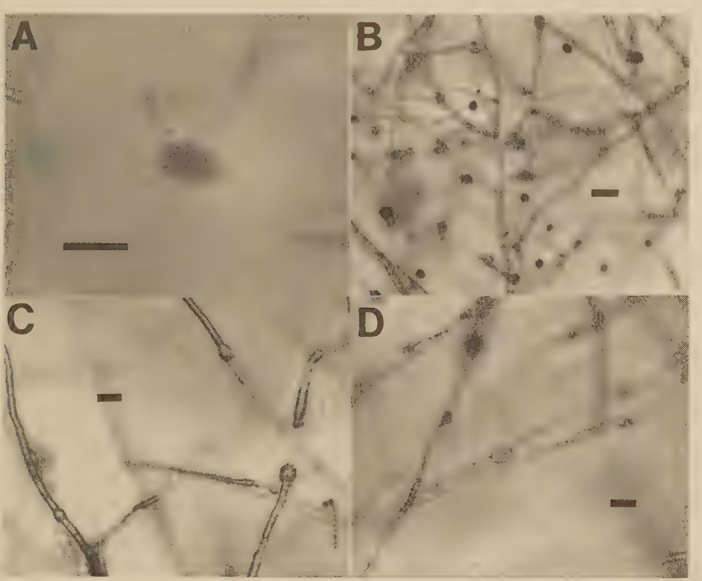


FIGURE 7. A. Extracellular deposit on hypha of isolate #969 immersed in malt extract agar. Bar = 20 μm. B. Abundance of extracellular deposits in culture of #969 on malt extract agar. Bar = 20 μm. C, D. Unicellular, intercalary chlamydospore-like cells in malt extract agar, produced by isolate #843. Bars = 20 μm.

(Morgan-Jones, 1974). The ovoid to subglobose shape of the conidia of *A. amaranthi* is consistent with the shapes of conidia of several *Microsphaeropsis* species (Morgan-Jones, 1974; Morgan-Jones and White, 1987; Sutton, 1980).

Aposphaeria amaranthi does not fit other Coelomycete genera because of pycnidial wall structure or the presence of conidiophores typifying the other genera. *Phyllosticta* is not an appropriate genus for *A. amaranthi* because the conidiogenous cells of *A. amaranthi* are not cylindrical or lageniform, and the conidia neither bear an appendage nor have a gelatinous coat (van der Aa, 1973; Yip, 1989).

Description:

Microsphaeropsis amaranthi (Ellis & Barth.) Heiny & Mintz comb. nov. (Fig. 8)

Syn.: *Aposphaeria amaranthi* Ell. & Barth., *Erythea* 4:4 (1896).

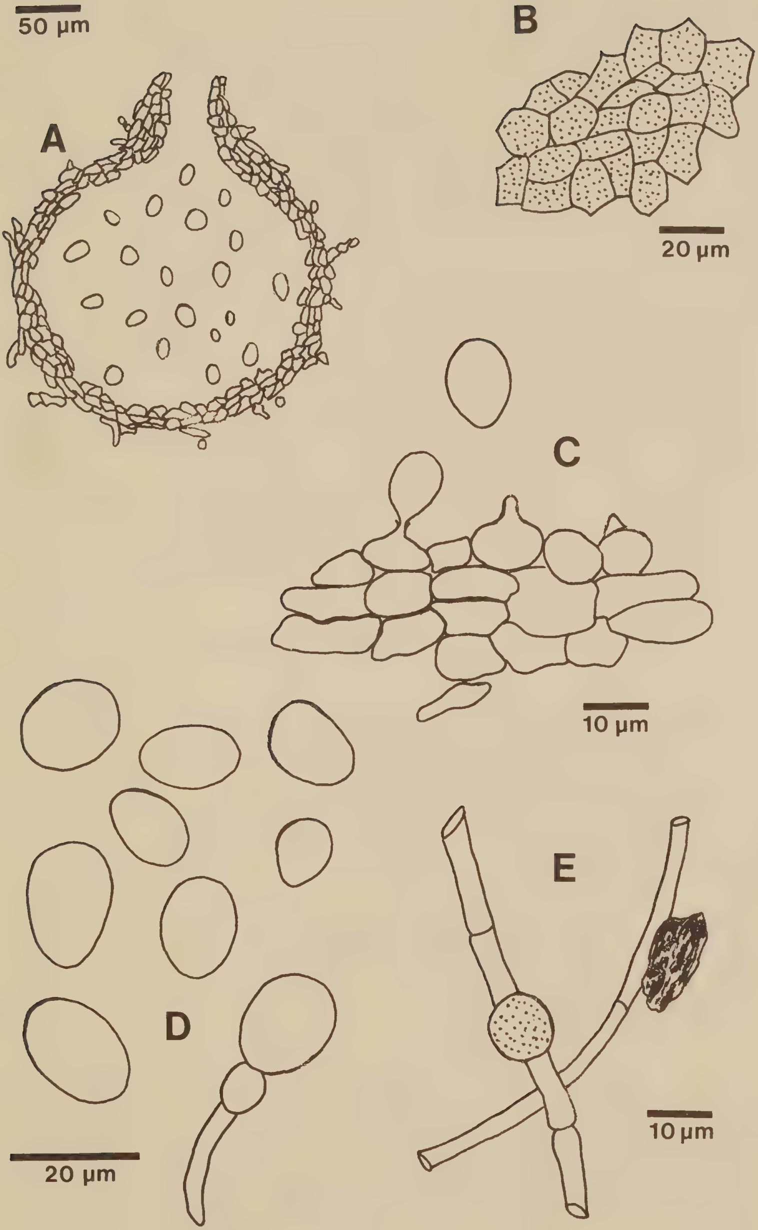
On dead stems of *Amaranthus retroflexus*, Rockport, Rooks Co., Kansas, June 21, 1895, collected by Elam Bartholomew, FH, type.

Causing ellipsoidal and elongated stem lesions on older *Amaranthus* species, especially *Amaranthus albus* L., often girdling the stem and comprising as much as one-third of the stem length, dark brown, surrounded by a blackish margin. Petiole lesions causing defoliation. Leaf lesions usually restricted, circular, about 2 mm in diameter, dark brown. Blighting of lateral branches. Seedlings killed.

Pycnidia superficial or semi-immersed, solitary, unilocular, olive green to brown or black, 140-480 μm in diameter, globose, thin-walled, ostiolate with a single circular pore of 30-45 μm in diameter. Wall with 2-4 cell layers, 11-22 μm thick, of textura angularis, covered with loose pseudoparenchymatous hyphae. Conidiogenous cells broadly simple, ampulliform, approximately 10 μm in diameter, phialidic.

Conidia one-celled, ovate to ellipsoidal or subglobose,

FIGURE 8. *Microsphaeropsis amaranthi* (=*Aposphaeria amaranthi*). A. Pycnidium. B. Surface view of cells in pycnidial wall. C. Conidiogenous cells. D. Conidia, including one germinated conidium with vesicle and germ tube. E. Intercalary chlamydospore-like cell (left) and extracellular deposit (right).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hyaline or yellow, pale buff to light olive green in mass, smooth-walled, 8-22 × 8-16 μm, mostly 15 × 12 μm. Multiple and variously sized guttules, randomly distributed, develop only in conidia from older cultures (3 weeks old). Cells of hyphae mostly straight-cylindrical, 3-9 μm in diameter, often bulging on either side of a septum. Colonies sparsely woolly, smooth on all media, with aerial mycelium less frequent when grown with illumination. Colony pigment white to pale pastel orange when young or at cooler temperatures (20°C), or on cellulose agar or pea juice agar. Mycelium ranging from white to gray to yellowish olive green on oatmeal, malt extract, and potato dextrose agars. The presence of numerous dark pycnidia on oatmeal agar and potato dextrose agar lends a dark appearance to cultures. Crystal formation was not observed. Extracellular, brown deposits are produced in malt extract agar and pea juice agar after 3 weeks. Occasional intercalary, unicellular chlamydospore-like cells develop in media.

Microsphaeropsis amaranthi is pathogenic to varying degrees on several *Amaranthus* species in addition to *A. albus*, including *A. retroflexus*, *A. spinosus*, and *A. hybridus* L. (Mintz *et al*., 1992).

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Our thanks to G. Morgan-Jones, Auburn University, for reviewing the manuscript and advising us on the appropriateness of *Microsphaeropsis* for this species.

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LACTARIUS sect. LACTIFLUUS AND ALLIED SPECIES

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Key words: *Lactarius*, section *Lactifluus*, taxonomy, phylogenesis.

Abstract: Twenty-seven taxa, all of them ascribable to the section *Lactifluus* of the genus *Lactarius*, have been taken into account. Many have been excluded, without absolute certainty at times, others put into synonymy mainly as a result of the microscopical analysis of the relative exsiccata. Those remaining have been divided into three subsections on the basis of their hypothesized phylogenetic relationship. A new species is also proposed, *Lactarius pegleri*, very similar to *L.hygrophoroides*, but separated by the pileipellis structure which unmistakably points to its placing in section *Allardi* Hesler & Smith.

INTRODUCTION

It was FRIES (1821) who first subdivided the genus *Lactarius*, but the circumscription of his taxonomic categories is too wide to define the group of fungi dealt with by us. The Swedish author established the groups *Galorrhei*, *Russulares* or *Subdulces* to include all the Lactarii exhibiting "pileus siccus, margine nudus. Lamellae confertae juniores albidae, dein lutescentes vel rufescentes. Substantia laxior," but distinguishes four species "dulces, pileo laevi," namely *Agaricus volemus*, *A. mitissimus*, *A. quietus*, and *A. subdulcis*. FRIES (1838) widens the group *Russulares* to eight species, including *Lactarius volemus* and its variety *oedematopus*, and defines it "lacte albo miti, pileo sicco glabro". Fries's system is followed by SACCARDO (1887), who numbers *L. volemus* with its varieties *oedematopus* and *subrugosus*, *L. princeps*, *L. hygrophoroides*, *L. distans*, *L. corrugis*, *L. lividatus* and *L. luteolus* among the *Russulares* "pileo polito, glabro". The same pattern will be followed by RICKEN (1910), who in the *Russularia* recognizes four groups among which the *`miti*', by LANGE (1935) who reckons *L. volemus* in the *Russularia*, *Glabrati*, *Lactosi* and by quite a few other authors. QUÉLET (1888) proposes an infrageneric subdivision at variance with Fries, is essentially based on pileus characters and includes *L. lactifluus*, a synonym of *L. volemus*, among the '*pruinosi*' with "voile pruineux, rarement visqueux", more precisely among the '*cyathiformes*' with "peridium charnu et ample, convexe, puis en coupe". BATAILLE (1908) and KONRAD (1935) rely heavily on Quélet's taxonomy, the latter subdivides Quélet's '*pruinosi*' into *Piperati* and *Dulces* and the second group is further subdivided into *Olentes*, *Subdulces* and finally *Volemi* which includes only *L. volemus* and are defined as follows "Chapeau charnu. Lait doux, blanc, très abondant. Chair et lamelles brunissant à l'air et au froissement". KUEHNER & ROMAGNESI (1953a), HEINEMANN (1960) and BLUM (1976) are in line with Konrad and place *L. rugatus* in the *Volemi*. As a matter of fact, Kuehner & Romagnesi include also *L. rubrocinctus* which, however, was transferred into the *Umbonati* soon after (1953b). NEUHOFF's taxonomy (1956), for the first time, focuses on microscopic characters, however their importance is over-estimated and as a consequence very closely related species like *L. volemus* and *L. rugatus* are accomodated into two different subsections of *Rhysocybe*, namely *Dictyosporini* and *Heterosporini*. BON (1980) turns many elements of Neuhoff's classification to good account integrating them into Quélet's frame-work, as a result his groupings are much more natural. SINGER (1975) includes a subsection *Lactifluini*, in section *Dulces* but its circumscription is slightly larger than that of the group under investigation. HESLER & SMITH (1979) name section *Lactifluus*, upgrading it, subsection *Lactifluae* by BURLINGHAM (1908), a group perfectly coextensive to the one we are going to discuss and define: "Pileus colored and the subcuticular or cuticular layer consisting of inflated cells or inflated cells numerous in the region; pileus dry, velutinous to unpolished, colors generally bright (yellow, orange and red), not dull as in *Plinthogalus*". We would like to make a separate mention of HEIM's systematic arrangement (1937, 1955), who inserted many tropical species into Quélet's system. The phylogenetical information drawn from these species persuaded him into giving the genus a sectional subdivision which was as natural as possible, taking into account not only morphological affinities but also evolutive ones. Heim declared his classification to be regarded as provisional, none the less the importance of his systematic method still holds good. According to the rules of the I.C.B.N. the correct name of the section under study is *Lactifluus* (Burlingham) Hesler & Smith, in fact it is the first that has been validly published at such a rank. We have also to hint at the name *Volemi* Konrad which, even though not validly published at the section rank, is currently used by most European authors.

Section *Lactifluus* (Burlingham) Hesler & Smith 1979, North American Species of *Lactarius*, Ann Arbor = *Volemi* Konrad 1935, Les Lactaries, Bull. Soc. Myc. Fr., **51**: 160-191, sensu Auct. pl.. Sporophore size medium to medium-large. Pileus with orange-tawny or brown-tawny colours, sometimes lighter (yellow-ochre to whitish) or darker (brick-red brown), always dry, finely velutinous, almost smooth, to velvety. Lamellae medium to very spaced. Stipe same colour as pileus or slightly paler. Latex copious, generally mild, often staining lamellae and context brown. Odour often herring-like (trimethylamine), taste mild. Pileipellis made up of a layer of subglobose cells bearing a turf of hairs. Spores globose reticulate, or ellipsoid, verrucose or reticulum more or less complete. Cystidia and hair-like marginal cells sometimes peculiar, subulate and very thick-walled or flexuose and capitate, more often than not clavate. Type species: *Lactarius volemus* (Fries) Fries 1838.

Key to species

1 Hymenial cystidia numerous, prominent, lanceolate and very thick-walled, spores globose or subglobose with a complete reticulum **2**
- Cystidia with walls thin or only slightly thickened, spores more or less elongated, verrucose or with an incomplete reticulum **6**
2 Cuticular cells small and dense, about 10 /um, pileal margin with plain concentric wrinkles .... *L. corrugis*
- Cuticular cells large, about 20 /um **3**
3 Lamellae spaced .... *L. austrovolemus*
- Lamellae somewhat crowded **4**
4 Pileus buff yellow .... *L. volemus* var. *flavus*
- Pileus with orange, brown-red colours **5**
5 Pileus orange tawny or orange brown .... *L. volemus*
- Pileus brick-red, with copper shades .... *L. volemus* var. *oedematopus*
6 Spores with a more or less complete reticulum, pileus with brown and orange colours, often with red shades **7**
- Spores dotted, pileus generally with light colours, white, yellow, ochre, seldom with orange or brown shades **8**
7 Context pink with FeSO4, lamellae moderately spaced .... *L. rugatus*
- Context unchanged with $FeSO_4$, lamellae distant .... *L. hygrophoroides*
8 Cuticle structure typical, hair-like cells perpendicular to pileus surface, long, threadlike, only rarely slightly capitate **9**
- Cuticle structure not typical **11**
9 Hymenial cystidia hair-like, more or less capitate, spores 7.0-8.0x5.0-6.0 /um .... *L. luteolus*
- Hymenial cystidia clavate, spores 8.5-10.0x6.5-7.5 /um **10**
10 Pileus buff ochre with orange and cinnamon shades, under *Leptospermum* .... *L. clarkei*
- Pileus orange brown or red orange, under *Nothofagus* .... *L. clarkei* var. *aurantioruber*
11 Cuticular hairs tangled to form a trichodermium parallel to pileus surface before turning upwards .... *L. caribaeus*
- Cuticular hairs short, up to 16 /um wide, often capitate or vesiculate .... *L. putidus*

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HERBARIA

AQUI: Herbarium Aquilanum, Università degli Studi, 67100 L'Aquila, Italy.
BCC: Departamento de Botanica, Facultad de Biologia, Universitad de Barcelona, Av. Diagonal 645, 08028 Barcelona, Spain.
FH: Farlow Reference Library and Herbarium of Cryptogamic Botany, Harvard University, 20 Divinity Avenue, Cambridge, Massachusetts 02138, USA.
FLAS: Herbarium, Departement of Botany, University of Florida, Gainesville, Florida 32611, USA.
K: The Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB, England, Great Britain.
MICH: Herbarium of the University of Michigan, North University Building, Ann Arbor, Michigan 48109, USA.
MPU: Institut de Botanique, 163 rue Auguste Broussonnet, 34000 Montpellier, France.
NYS: Herbarium, New York State Museum, Biolog. Survey, 3132 CEC, Albany, New York 12230, USA.
PACA: Herbarium Anchieta, Instituto Anchietano e Unisinos, 93000 Sao Leopoldo, Rio Grande do Sul, Brasil.
PAV: Botanical Institute, The University, P.O. Box 99, 27100 Pavia, Italy.
PC: Muséum National d'Histoire Naturelle, Laboratoire de Cryptogamie, 12 rue de Buffon, 75005 Paris, France.
PDD; Herbarium, Plant Diseases Division, Departement of Scientific and Industrial Research, Mt. Albert Research Centre, Private Bag, Auckland, New Zealand.
PI: Herbarium Horti Pisani, via L. Ghini 5, 56100 Pisa Italy.
RO: Erbario dell' Istituto Botanico dell' Università di Roma, Città Universitaria, 00100 Roma, Italy.
SP: Herbario do Estado "Maria Eneyda P. K. Fidalgo", Instituto de Botanica, Caixa Postal 4005, 01000 Sao Paulo, Sao Paulo, Brazil.
TENN: Herbarium, Department of Botany, University of Tennessee,Knoxville, Tennessee 37916, USA.
UPS: The Herbarium, University of Uppsala, P.O. Box 541, S-751 21 Uppsala, Sweden.

The herbarium directors' willinguess to provide us with the loan of exsiccata is aknowleged. A special thank is due to Dr D.N. Pegler of Kew Herbarium (GB) for sending us slides of *Lactarius caribaeus* and *L. putidus*. Dr T. Hongo (Shiga University, Otsu, Japan) and Dr J. Llistosella (Barcelona, Spain) are also entitled to our gratitude for supplying specimens from their personal herbaria.

LACTARIUS CORRUGIS Peck 1879, Ann. Rep. N.Y. State Mus., **32**: 31.
Lactarius volemus var. *subrugosus* Peck 1885.
Etymology: lat., corrugis, e = wrinkled.
Iconography: Atkinson 115; Hard 118; Hesler & Smith 28 & 151; Miller 61; Smith & Weber 239.
Illustrations: fig. 1, pl. 1a.

Pileus (4)-5-12-(20) cm wide, convex to depressed, dark vinaceous brown at centre, paler at margin, sometimes orange-cinnamon to ferruginous, dry, conspicuously velvety, concentric wrinkles quite obvious near margin. Lamellae adnate-subdecurrent, pale ochre to buff, brown when broken, close, medium broad, sometimes forked. Stipe 5-11 cm long, 1.5-2.5(-3) cm thick, equal, grey-brown, sometimes with red-brown shades, paler than pileus. Context white staining brown, taste and odour slight; latex white, unchanging, copious, staining tissues brown. Spores globose or subglobose, (7.4)7.9-10.5(12.1)x(6.8)7.5-9.7(10.9) μm, vol. 358.4 μm^3, Q = 1.07, reticulum more or less complete made up of medium marked connectives and some thinner lines; spore print white. Basidia four-spored, 55-60x9-11.5 μm. Cystidia numerous, 70-80x6.5-8 μm, lanceolate, thick-walled, conspicuous. Pileipellis with very long hairs, about 120-150x4 μm, rising from a dense layer of small, irregularly roundish cells.

Habitat and distribution: on soil in deciduos and mixed woods, June-September; United States, Mexico, Japan and China.

TYPE: C. H. Peck, New York, USA (NYS).

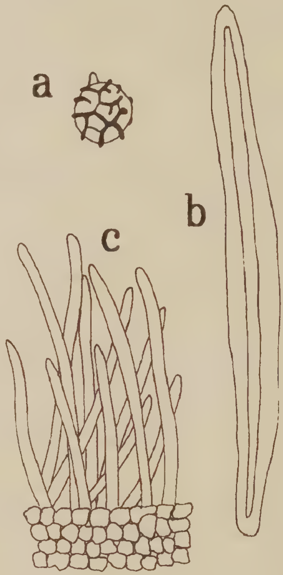

Fig. 1 - *Lactarius corrugis:* a) spore, b) cystidium, c) pileipellis structure.

COLLECTIONS EXAMINED: **AQUI**: G. Pacioni, 7/8/1983, Michigan, USA. **K**: D.A. Reid, 4260/80-6, Tennessee, USA; A. H. Smith, 4260/80-6, Michigan, USA. **MICH**: G.S. Burlingham, 13/8/1907, North Carolina, USA; W.B. & V.G. Cooke, 35486, Ohio, USA; F. Hoseney, 912, Michigan, USA; B. I saacs, 2527, Florida, USA; C.H. Kauffman, 13/9/1926, Pennsylvania, USA; L.C.C. Krieger, Kelly 134, Maryland, USA; D. Lewis, 516, Texas, USA; G.W. Martin, 14/6/1939, Iowa, USA; A.H. Smith, 10200, Tennessee, USA; N.S. Weber, 4451, Georgia, USA; R.Mc. Vaugh, 241, Mexico.

OBSERVATIONS: Very similar to *Lactarius volemus* (Fr.) Fr., this species is distinguished by a series of characters which nevertheless, according to SMITH (1977) and HESLER & SMITH (1979), are very variable in fruit-bodies of the same species and sometimes present in fruit-bodies of the other species, so that a number of collections look as if intergrading occurs. However, *L. corrugis* is distinguished by the bigger spores, the striking wrinkling of pileus and the darker colours. In our opinion the structure of the pileipellis appears sufficiently different to separate the two species. In *L. corrugis* the cuticular hairs are much longer and more numerous and often apparently woven into a trichodermium, and are borne by a very compact layer of cells which, contrary to what is observed in *L. volemus*, is made up of relatively small, very irregularly roundish cells. This kind of structure is hardly to be included in our definition of sect. *Lactifluus*, but we think that the striking similarity both in field characters and microscopically with *L. volemus* is essential for inclusion in the group under investigation. For what concerns *L. volemus* var. *subrugatus* we believe, in line with HESLER & SMITH (1979), that it has to be placed in synonymy with *L. corrugis*. LANGE (1935), who collected it in North America, regards it as a transitional form between *L. volemus* and *L. corrugis*.

LACTARIUS VOLEMUS (Fries) Fries 1838, Epicr. Syst. Mycol., 344
Agaricus lactifluus Linneo 1753, Species plantarum, 1172.
Agaricus volemus Fries 1821, Syst. Mycol., Vol. 1, 69.
Agaricus lactifluus aureus Hoffmann 1789, Nomenclator fungorum.
Agaricus dycmogalus Bulliard 1791, Hist. Champ. France.
Agaricus testaceus Albertini & Schweinitz 1805, Conspectus fungorum, 209 (non Krombholz 1831/47).
Agaricus ruber Secretan 1833, Mycographie suisse, 89 (non Persoon 1801 et Trattinick 1809).
Agaricus ichoratus Krombholz 1831, Natur. Abbil..
Lactarius lactifluus Quelet 1886, Enchiridion fungorum, 131.
Lactaria volema Schroet. 1889, Pilze Schles. I, 535
Lactaria lactiflua Burlingham 1908, Mem. Torrey Bot. Club, **14** (1): 90.
Etymology: lat., volemum pirum = pear which fits into a hand palm. Same size as a pear.
Popular names: lattario volemo, peveraccio giallo, vacchetta (Italy); lactaire grosse poire, lactaire à lait abondant, lactaire orange doré, lamburon, rougeole à lait doux, vache, vachette, vachotte, velo, vio (France); orange-brown Lactarius (Great Britain); kenyérgomba (Hungary); syrovinka (Czechoslovakia); kultariska (Finland); milda brotlingen, mandelriska (Sweden); spiselig maelkehat (Denmark); bratling, bradling, gold-pratling, gold-brotling, milch-brotchen, brotpilz, milch-bratling, birnen-milchling, semmerfarbener milchling, bruckling, sussling (Germany).
Iconography: Blum 16; Bresadola 390; Britzelmayr 6; Bulliard 584; Cetto 176; Cooke 999; Fries 10; Gillet 170; Gramberg 14; Hesler & Smith 29 & 56b; Imazeki & Hongo 23, 248; Korhonen p.184-185; Krombholz 39, 1-4; Lange 176g; Marchand 147; Michael & Hennig 5, 54a; Miller 62; Neuhoff 13, 51; Pacioni (1981) 127; Patouillard 323; Peck (1897) 30; Phillips p. 88; Ricken 14, 3; Rolland 72; Romagnesi 17; Smith & Weber 240; Svrcek & Kubicka p. 257; and quite a few others.

Illustrations: fig. 2, pl. 1b & 1d.

Pileus 5-15 cm wide, convex, then expanding to plane, depressed at centre, at times funnel-shaped, orange-tawny to orange-brown, at time paler with ochre or yellow shades, generally darker at centre with reddish shades, dry, more or less velvety, surface rimose in old specimens. Lamellae adnate subdecurrent, whitish, then pale ochre-cream, medium broad and crowded, sometimes forked, staining brown when touched. Stipe 5-12 cm long, 1-2.5 cm thick, equal, slightly tapering at base, sometimes swollen in the middle, concolorous with the pileus or paler, ochre-cream, pruinose. Context whitish, slowly staining brown, taste mild, odour strong, peculiar, herring-like or similar to topinambur; latex white, mild, very copious. Spores globose to subglobose, (7.1)7.8-9.7(11.1)x(6.7)7.4-9.1(9.9) µm, vol. 309.4 µm^3, Q = 1.06, ornamentation made up of a complete, medium-sized mesh, resulting from somewhat marked lines and a few thinner ones; spore print white. Basidia 4-spored, 50-70x9-11 µm. Cystidia 50-80x7-9 µm, characteristic, quite prominent, lanceolate and very thick-walled. Pileipellis made up of a layer of roundish cells which bears quite a few hairs, 3-5 µm wide and up to 90 µm long; thick-walled pileocystidia similar to hymenial ones also present. Stipe cuticle structure the same as in the pileus.

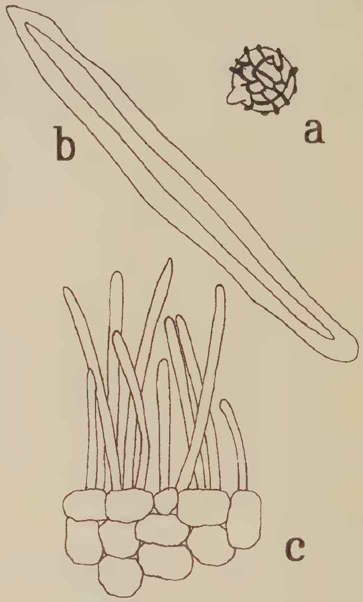

Fig. 2 - *Lactarius volemus*: a) spore, b) cystidium, c) pileipellis structure.

Habitat and distribution: on soil, under various broad-leaved trees, especially oaks, chestnut-trees, beeches and hornbeams, but under conifers as well, June to September; widespread in Europe even though uncommon in Northern regions, common and wide-spread also in Central-Northern America, rare in Northern Africa where apparently it is substituted by *Lactarius rugatus* K. & R., present also in Japan, China and Asia Minor.

TYPE: lacking.

COLLECTIONS EXAMINED: **AQUI**: G. Lalli, 19/7/1979, L'Aquila, Italy; G. Lalli, 8/8/1979, L'Aquila, Italy; G. Lalli, 14/9/1979, Trento, Italy; G. Lalli, 18/9/1980, Trento, Italy; G. Lalli, 25/6/1981, L'Aquila, Italy; G. Lalli, 21/9/1981, Ceva, Italy; G. Pacioni, 25/7/1983, Michigan, USA; G. Pacioni, 1/8/1983, Michigan, USA. **BCC**: Cotxet, 85-491, Spain; Vigueras, 84-228, Spain. **K**: F. Baglietto, 4260/80-1, Italy; J.B. Barla, 4260/80-3, Alpes Maritimes, France; Bloxam, 4260/80-4; C.E. Brome, 4260/80-5, Great Britain (unidentified species); R.W.G. Dennis, 4260/80-5, Great Britain; E. E. Green, 4260/80-5, Great Britain; G. Herpell, 4260/80-2, St. Goarshausen; T.G. Lea, 4260/80-2, Ohio, USA; J.A. Lee, 4260/80-5, Great Britain; A. Melderis, 4260/80-2, Sweden; W. Phillips, 4260/80-5, Great Britain; H.W. Ravenell, 4260/80-2, South Carolina, USA; H.W. Ravenell, 4260/80-4, Georgetown, USA; D.A. Reid, 4260/80-2, Tennessee, USA; D.A. Reid, 4260/80-3, Bulgary; R.J. Shittleworth, 4260/80-1; C.J. Sprague 4260/80-3, New England (unidentified species); P. Sydow, 4260/80-1, Berlin, Germany (unidentified species); De Theumen, 4260/80-1, Bohemia; J.G. Trog, 4260/80-1; 4260/80-2, Carol. Sup., USA; 4260/80-3, Baumwald. **MICH**: J. Ammirati, 2487, Michigan, USA; W.B. & V.G. Cooke, 4288, Tennessee, USA; W.B. & V.G. Cooke, 35576, Ohio, USA; K.A. Harrison, 12271, Nova Scotia, Canada; E. Hillhouse, 132, Texas, USA; H.P. House, 4/8/1945, New York, USA; B. Isaacs, 2160, New York, USA; B. Isaacs, 2526, Florida, USA; C.H. Kauffman, 3/9/1924, Pennsylvania, USA; L.C.C. Krieger, Kelly 70, Maryland, USA; L.C.C. Krieger, Kelly 81, Maryland, USA (as *L. luteolus*); D. Lewis, 1064, Texas, USA; S.J. Mazzer, 6710, Wisconsin USA; R. Mc Vaugh, 364, Mexico; R.L. Shaffer, 4160, France; R.L., Shaffer, 4852, France; R. L. Shaffer, 5627, Quebec, Canada; R.L. Shaffer, 6160, North Carolina, USA; R.L. Shaffer, 6194, North Carolina, USA; R.L. Shaffer, 6359, Indiana, USA; A.H. Smith, 30/7/1931, Nova Scotia, Canada; A.H. Smith, 57182, Michigan, USA; A.H. Smith, 80252, Belgium; R. Zehner, 72, Michigan USA. **MPU**: P.O. Shallert, 14/8/1959, Florida USA (unidentified species). **PAV**: F. Baglietto, june 1860, Genoa, Italy. **RO**: F. Baglietto, june 1860, Genoa, Italy. **SP**: O. Fidalgo, 22/8/1958, Indiana, USA. **UPS**: S. Lundall & J. Stordal, 6068, 4/9/1949, Sweden.

OBSERVATIONS: This is one of the most wide-spread and well-known fungi, hunted and prized as food in many areas. Concerning its distribution we have made mention of its rarity in Northern Africa (BERTAULT, 1978) where as *L. rugatus* is common and abundant. The situation is similar in Italy, in the National Park of Circeo (LALLI & PACIONI, 1981), where in a strictly Mediterranean habitat, *L. volemus* is absent while *L. rugatus* is likely to represent the most wide-spread species in the genus. *L. volemus* exhibits a remarkable variability in some of its characters as observed by SMITH (1977) and HESLER & SMITH (1978). In some collections, gills are forked dichotomously, latex turning yellow, as already noted by FRIES (1838), REA (1922) and BRESADOLA (1928), latex whey-like and other characters not fitting in with the type but uncorrelated with each other.

LACTARIUS VOLEMUS var. OEDEMATOPUS Scopoli: Fries 1838 Epicr. Syst. Mycol., 345

Agaricus lactifluus Schaeffer 1762, Fungorum Icones, 5 (non Linneo 1753).
Agaricus oedematopus Scopoli 1772, Flora Carniolica, II, 453.
Agaricus ruber Trattinick 1809, Die Essb. Schw. des Osterr. Kais., 89 (non Secretan 1883).
Agaricus volemus b Fries 1821, Systema Mycologicum, 69.
Agaricus ruber lactifluus Secretan 1833, Mycographie suisse, 451.
Agaricus volemus Barla 1859, Les Champignon de la province de Nice, 36.
Etymology: gr.oidema = swelling; gr. pous, podos = foot. With a swollen foot.
Iconography: Barla 20, 1-3; Cetto 1053; Krombholz 34, 2-3; Michael & Hennig 5, 54b; Nehuoff 13, 51a; Schaeffer 5; Trattinick 20.
Illustrations: fig. 3.

Pileus 4-8 cm, convex, then applanate, depressed at centre, of a typical red-brown colour with some shade of copper or chestnut, dry, tomentose, with an olive-grey frosted covering, margin long inrolled. Lamellae adnate-subdecurrent, at first light ochre, later more saturated with orange shades, not forked, staining brown. Stipe 3-6 cm long, about 2 cm thick, equal, sometimes swollen in the middle, ochre cream towards apex, concolorous to the pileus towards base, squat like the whole sporophore. Context whitish, slowly turning brown, same odour as type; latex white, mild, very copious. Spores globose to subglobose, (7.4)8.2-9.8(10.2) x (7.0)7.8-9.3(9.8) /um, vol. 334.9 /um^3, Q = 1.06, reticulum complete with medium-marked lines and a few thinner ones, spore print white. Basidia four-spored, up to 70 /um long and 9-11 /um wide. Cystidia 50-80x7-9 /um lanceolate and very thick-walled.

Habitat and distribution: on soil, under various broad-leaved trees but also in coniferous woods; rather wide-spread in Central-Southern Europe even though not very common.

TYPE: lacking.

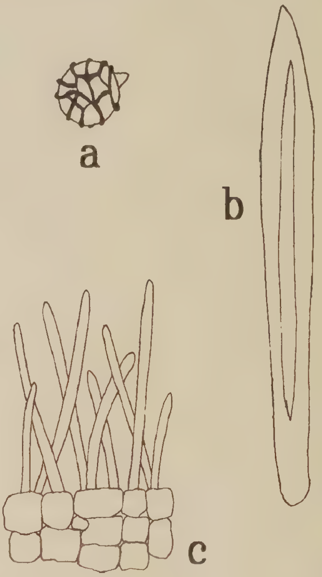

Fig. 3 - *Lactarius volemus* var. *oedematopus:* a) spore, b) cystidium, c) pileipellis structure.

COLLECTIONS EXAMINED: **AQUI**: G. Lalli, 14/9/1979, Trento, Italy; G. Lalli, 3/7/81, Marana, Italy; G. Lalli, 15/9/1981, Borgotaro, Italy; G. Lalli, 21/9/81, Ceva, Italy. **RO**: F. Baglietto, luglio 1860, Valle della Polcevera, Italy; O. Comes, Portici, Italy.

OBSERVATIONS: This variety is not accepted by a number of authors probably because in their opinion the forms with dark pilei are to be included in the colour range of *Lactarius volemus* (Fr.) Fr.. Other authors, from FRIES (1838) to MOSER (1978) and BON (1980) keep the forms sharply separated. It was NEUHOFF (1956) who reevaluated Fries' taxon on the grounds of specimens collected in Germany under beech, even if he considered whether actually the fungus is any more than a variant of *L. volemus*. Microscopically there is no difference between the two forms and also field characters are not always distinct; in particular the "swollen stem", which justifies its name, is not a constant character of dark forms. On the contrary, we happened to note it in fruit-bodies referred to typical *L. volemus* for all other characters. In addition we have collected the two forms together in oak and chestnut woods in the neighbourhood of L'Aquila, so they have not even a different habitat. The only distinguishing characters left are stature and colours, perhaps too little to recognize this entity at varietal rank. Probably it would be better to regard it as a simple form.

LACTARIUS VOLEMUS var. **FLAVUS** Hesler & Smith 1979 North American Species of *Lactarius*, 165.
Lactarius volemus var. *subrugatus* Neuhoff 1956, Die Milchlinge, 188 (ad interim).
Lactarius volemus var. *aberrans* Bouchet 1959 Bull. Fed. Fr. Soc. Sc. nat., **17**: 51 (nomen nudum).
Etymology: lat., flavus = bright yellow.
Iconography: Bull. Fed. Fr. Soc. Sc. nat. **17**: 51; Michael & Hennig 5, 54c; Neuhoff 13, 51b.
Pileus (2)-5-9 cm wide, plano-convex then depressed, ivory-yellow to buff-yellow, dry, velvety, bruising brown. Lamellae adnate, whitish, later cream colour, crowded, narrow to medium broad, often forked near stipe. Stipe (3)-5-10 cm long (0.4)-0.8-1.6 cm thick, cream to maize-yellow, equal, dry and velvety. Context whitish, taste mild, odour strong and fetid, at times lacking; latex white, unchanging, mild, staining every part of the fruit-body brown. Spores (6.5)-7-8.5-(9)x6-7.5-(8) /um globose to subglobose or broadly ellipsoid, reticulum more or les complete; spore print white. Basidia two- and four-spored, 36-40x7-8 /um. Cystidia 40-70-(92)x5-10 /um, lanceolate, thick-walled, obtuse to acute at apex. Pileipellis a layer of roundish cells bearing thin-walled hairs measuring 22-34x3-6 /um.
Habitat and distribution: on the ground in deciduous and coniferous (Picea) woods, rare, June to September; United States (Alabama, Mississipi and Tennessee) and Europe.
TYPE: L. R. Hesler 26934, Tennessee, USA (TENN).
OBSERVATIONS: HESLER & SMITH (1979) recognize this variety by the slightly smallers spores (according to them the type variety has spores measuring 7.5-9-(10)x7.5-8.5-(9) /um), a mainly southern distribution and the yellow colour of the pileus which is constant throughout the development of fruit-bodies and within the populations. NEUHOFF (1956) reports collecting a close ally of *Lactarius volemus* (Fr.) Fr. with pileus more or less yellow under spruce only once. Having kept only its drawing he names it *L. volemus* var. *subrugatus* ad int. recommending further field investigations. Judging by the plate it is safe to conclude that a light form of *L. volemus* or an especially yellow one of *L. luteolus* Peck are out of question, as a consequence, pending new collections, we suggest a synonymy with Hesler & Smith's variety. The single clashing character which remains is the pileus "concentrically wrinkled" of Neuhoff's description, however this character is not particularly evident in his plates. Another fungus which might be placed in synonymy with *L. volemus* var. *flavus* is *L. volemus* var. *aberrans*, which has not been published validly though.

LACTARIUS AUSTROVOLEMUS Hongo 1973, Rept. Tottori Mycol. Inst., **10**: 357-364.

Etymology: lat., australis, e = southern. A *L. volemus* from the southern hemisphere.

Illustrations: fig. 4, pl.1c.

Pileus 4-6 cm wide, convex to subdepressed, golden yellow to brown-orange, dry, finely pruinose. Lamellae adnate-subdecurrent, cream colour, distant, bruising brown. Stipe 5-6 cm long, 1-1.7 cm thick, equal, paler than pileus, finely pruinose. Context whitish, becoming slowly brown, taste mild, odour herring-like; latex white, mild, very abundant. Spores globose or subglobose (7.0)7.4-9.3(10.8)x(6.5)7.0-8.8(10) /um, vol. 270.2 /um^{3}, Q = 1.06, ornamentation of warts and ridges connected to form a complete reticulum; spore print white. Basidia four-spored 35-42x11-15 /um. Cystidia 50-95x6-8 /um, lanceolate, with very thick walls. Pileipellis a layer of roundish cells from which rise hairs 28-52 /um long and 3.3-4.7 /um thick.

Habitat and distribution: on soil, in *Castanopsis* woods; New Guinea.

TYPE: T.Hongo, 6129, New Guinea (Herb. Hongo).

COLLECTIONS EXAMINED: Herb. Hongo: T. Hongo, 6129, New Guinea (isotypus).

OBSERVATIONS: This species bears a strong resemblance to *Lactarius volemus* (Fr.) Fr.. Micro-characters are hardly different, only spores are slightly smaller and with some raised warts in addition to ridges. Rather easily distinguished in the field by its distant gills, character conspicuous even in exsiccata, and by its tall habitus, more similar to that of *L. hygrophoroides* Berk. & Curt. than to of *L. volemus*.

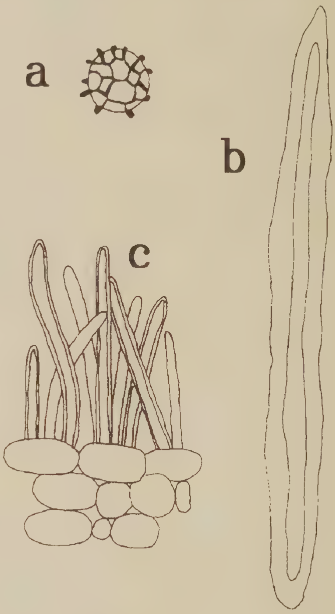

Fig. 4 - *Lactarius austrovolemus*: a) spore, b) cystidium, c) pilcipellis structure.

LACTARIUS RUGATUS Kuehner & Romagnesi 1953, Bull. Soc. Mycol. France, **69**: 362.

Lactarius hygrophoroides Berkeley & Curtis sensu Bresadola in Martelli 1903.

Lactarius volemus var. *bourquelotii* Boudier (in herbario, fide Blum 1976).

Lactarius hygrophoroides var. *rugatus* Hesler & Smith 1979.

Etymology: lat., rugatus, a, um = wrinkled.

Iconography: Cetto 1504; Corrias & Corrias 2; Marchand 569; Michael & Hennig 5, 54 a; Pacioni (1980) 65.

Illustrations: fig. 5, pl. 2a.

Pileus 4-9 cm wide, convex, then plane, more or less depressed at centre, orange red-brown, darker at centre, pruinose, velvety, dry, concentrically wrinkled towards margin. Lamellae slightly decurrent, cream colour, later with ochraceous and orange shades, bruising slightly brown, distant. Stipe 3-7 cm long, 1-2 cm thick, fulvous, darker, orange red towards base, equal, pruinose or minutely velvety, dry. Context whitish, staining faintly brown when exposed, taste mild, odour similar to that of *Lactarius volemus* (Fr.) Fr. but less strong, pinkish with $FeSO_4$; latex white, unchangeable, copious. Spores ellipsoid bean-like, (7.8)8.1-9.5(9.9) x (5.6)5.9-6.6(6.8) /um, vol.173.1 /um^3, Q = 1.41, ornamentation of crests and warts forming an almost complete reticulum; spore print white. Basidia 4-spored, 40-60x8-10 /um. Cystidia of the common type, clavate, 50-65x6-8 /um, with more or less minute granular contents. Pileipellis a lower layer of roundish cells giving rise to an upper one of thin-walled hairs 3-4.5 /um wide.

Habitat and distribution: terrestrial under various broad-leaved trees, September-November; France Italy, Algeria, Tunisia and Marocco.

TYPE: Romagnesi, 22/9/45, Oise, France (Herb.Romagnesi).

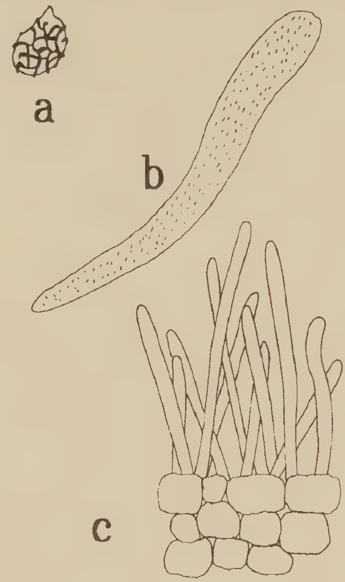

Fig. 5 - *Lactarius rugatus*: a) spore, b) cystidium, c) pileipellis structure.

COLLECTIONS EXAMINED: **AQUI**: G. Lalli, 3/11/81, National Park of Circeo, Italy; G. Lalli, 27/10/82, Cecina, Italy; G. Pacioni, 28/9/78, National Park of Circeo,Italy; G.Pacioni, 27/10/79, National Park of Circeo, Italy; G. Pacioni, 9/12/82, Tunisia; G. Pacioni, 22/12/82,Marocco. **BCC**: Llistosella, 83-20, Spain; Llistosella, 84-254, Spain. **K**: H.W. Ravenel, 4360/80-4 (as *L. volemus*). **MICH**: R.L. Shaffer 4780, France (as *L. hygrophoroides* var.*rugatus*). **PC**: H. Romagnesi 55152, Oise, France; Exposition mycologique du Museum, octobre 1959, Paris, France (as L. volemus). **PI**: E. Barsali 16/11/1903, Tombolo, Pisa, Italy (as *L. hygrophoroides*).

OBSERVATIONS: HESLER & SMITH (1979) regard this taxon as a variety of *L. hygrophoroides* Berk. & Curt. based on the almost absolute similarity of microscopical characters. On the other hand, the two authors have not observed fresh material but only European or North American exsiccata. We cannot accept this disposition since there are numerous differences in field characters between the two fungi, accordingly we consider them distinct species. First and foremost the habit: *L. hygrophoroides* is more slender, while generally *L. rugatus* K. & R. has a stipe shorter than the pileus diametre. The colour, also, is different, lighter and often with yellow tinges in *L. hygrophoroides*; in addition *L. rugatus* has a pileus concentrally wrinkled near margin, gills less distant and not interveined flesh staining brown and pinkish with FeS04 and a herring-like smell. Above all the spores, also, prove diagnostic in the separation of the entities. In *L. rugatus* they are slightly longer and with ornamentation forming a more complete reticulum. BLUM (1976) reports having found this species in Boudier's herbarium as *L. volemus* var. *bourquelotii*, while KUEHNER & ROMAGNESI (1953b) have found it in Maire's herbarium as *L. volemus* (Fr) Fr, which demonstrates that *L. rugatus* even though fairly common in southern Europe has been misidentified for a long time. As already reported (PACIONI & LALLI, 1981) this species is rather widespread in Mediterranean areas. MARTELLI (1903) had already collected it at the beginning of the century and Bresadola determined it as *L. hygrophoroides*.

LACTARIUS HYGROPHOROIDES Berkeley & Curtis 1859, Ann. Mag. Nat. Hist., 3rd ser., **4**: 293.

Lactarius distans Peck 1872, Ann. Rep. N.Y. State Cab., **23**: 117.

Lactarius subvelutinus Peck 1904, Bull. N.Y. State Mus., **75**: 18.

Lactarius cystidiosus Thiers 1957, Mycologia, **49**: 714.

Lactarius hygrophoroides var. *odoratus* Hesler & Smith 1979 North American species of *Lactarius*, 173.

Lactarius hygrophoroides var. *rugatus* (Kuehner & Romagnesi) Hesler & Smith 1979 North America Species of *Lactarius*, 175.

Lactarius hygrophoroides var. *lavandulaceus* Hesler & Smith 1979 North American species of *Lactarius*, 176 (as *lavendulaceus*).

Misapplied names: *Lactarius hygrophoroides* sensu Bresadola in Martelli 1903, Bull. Soc. Bot. Ital., 307-309 (= *Lactarius rugatus* K.& R.).

Etymology: gr., eidos = resemblance. Like an *Hygrophorus*.

Iconography: Groves 62; Miller 52; Murril 187, 2; Peck (1901) 53, 7-11 (*L. distans*); Pegler & Fiard 10, e & f.

Illustrations: fig. 6, pl. 2b.

Pileus 3-10 cm wide, at first convex, then plane more or less depressed at centre, cinnamon-orange to darker, with reddish, brown or even yellow tinges, dry, pruinose or finely velutinous. Lamellae adnate-subdecurrent, white, then yellowish-cream, broad, very distant, intervenose, not forking. Stipe 3-5 cm long, 0.5-1.5 cm thick, equal, concolorous with the pileus but paler, dry and pruinose. Context white, taste mild and odour slight; latex white, unchangeable. Spores ellipsoid, (7.5)7.9-9.2(9.9)x(5.5)5.8-6.8(7.1) /um, vol.174.3 /um^3, Q = 1.35, ornamentation of moderately marked lines forming a very broken reticulum; spore print white. Basidia 4-spored, 50-60x8-9 /um, with fine internal dots. Marginal and facial cystidia hardly differentiated, cylindrical-clavate, 55-65 /um long and 8-9 /um wide, with thin walls and fine internal granulations. Pileipellis made up of a lower layer of roundish cells up to 25 /um broad giving rise to numerous hairs up to 70 /um long and 3-4.5 /um wide, with thin or sometimes slightly thickened walls. Stipitipellis with structure similar to that of the pileus.

Habitat and distribution: on soil, under various broad-leaved trees, June to September; United States, Canada, Mexico and Japan.

TYPE: C.J. Sprague, 6194, Maine, USA (K).

COLLECTIONS EXAMINED: **AQUI**: G. Pacioni, 24/7/1983, Michigan, USA; G. Pacioni, 31/7/1983, Michigan, USA. **K**: J.W. Groves 33905, 4260/80-8, Quebec, Canada; C.J. Sprague 6194 (typus), Maine, USA, 4260/80-9; Underwood 4260/80-10 (as *L. distans*). **MICH**: K.A. Harrison 11668, Nova Scotia, Canada (as *L. hygophoroides* var. *rugatus*); R.L. Homola 5676, Maine, USA; F. Hoseney 17/8/1973, Michigan, USA; B.F. Isaacs 2344, Florida, USA; C.H. Kauffman, 16/9/1924, Pennsylvania, USA; J. Kimbrough & A.H. Smith, 3/5/72, Florida, USA (as *L. hygrophoroides* var. *rugatus*); R. Mc Vaugh 568, Mexico; C. Nimke 578, Michigan, USA (paratypus of *L. hygrophoroides* var. *rugatus*); P.M. Rea 804, Michigan, USA; R.L.Shaffer 3149, Vermont, USA; R.L. Shaffer 5942, Quebec, Canada; R.L. Shaffer 6226, North Carolina, USA.; R.L. Shaffer 6339, Indiana, USA; A.H. Smith 716, Nova Scotia, Canada; A.H. Smith 7325, Tennessee, USA; A.H. Smith, 78477, Michigan USA (as *L. hygrophoroides* var. *rugatus*); A.H. Smith, 84285, Michigan, USA (isotype of *L. hygrophoroides* var. *lavandulaceus*); H.D. Thiers, 1670, Texas, USA, (holotypus of *L. cystidiosus*); H.D. Thiers 4710, Texas, USA. **NYS**: Peck, Albany country, August, New York, USA (typus of *L. subvelutinus*). **PC**: P.O. Shallert, 25/7/1957, Florida, USA (as *L. volemus*). **SP**: G.W. Martin, 9/8/1946, Iowa, USA (unidentified species). **TENN**: L.R. Hesler, 23378, North Carolina, USA (isotypus of *L. hygrophoroides* var. *odoratus*).

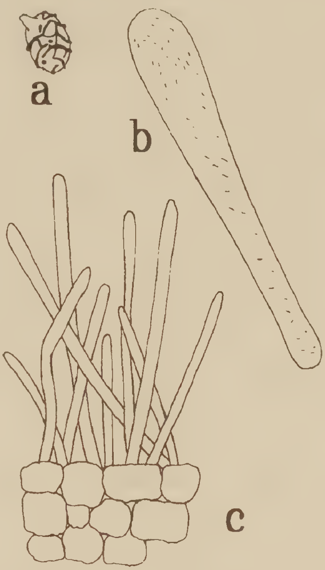

Fig. 6 - *Lactarius hygrophoroides*: a) spore, b) cystidium, c) pileipellis structure.

OBSERVATIONS: After studying Peck's type, HESLER & SMITH (1979) place *Lactarius distans* in synonymy with *L. hygrophoroides*. Further, the collection of *L. distans* examined by us agrees in all respects with this species. Regarding the three varieties proposed by HESLER & SMITH (1979), we have ascertained a complete microscopic identity with the type. Accordingly they cannot be considered autonomous entities, and there are additional reasons. *L. hygrophoroides* var. *rugatus* is based on a European collection which we have examined and found to be true *Lactarius rugatus*, and on some American collections mostly with unknown $FeSO_4$ reaction. *L. hygrophoroides* var. *lavandulaceus* is separated on the basis of the vinaceous or lavender colour-change of lamellae, the yellowish spore-deposit, the green reaction with $FeSO_4$, the browning of latex and context, but the authors note the possibility of collections with white spore-deposit and absence of reactions. The original spelling *lavendulaceus* from "lavender" in English, is to be replaced by the correct *lavandulaceaus* from Latin "lavandula". *L. hygrophoroides* var. *odoratus* would be separated only for the strong alkaline odour or similar to that of *Lactarius volemus*, which, however is finally present in all exsiccata of *L. hygrophoroides.* Therefore it is conclused that *L. hygrophoroides* should be regarded as a single entity, with some variability in smell, latex and context colour-change, variability which is confirmed in some of our North American collections. One problem remains unsolved, that posed by the few collections exhibiting a pinkish or greenish reaction with $FeSO_4$. These reactions need be reassessed on fresh material and possibly coupled with other field characters to be able, eventually, to distinguish one or more varieties in the complex *hygrophoroides. L. cystidiosus*, also, put into synonymy with *L. hygrophoroides* var. *odoratus*, by HESLER & SMITH (1979), exhibits no difference as compared to the type, lacking even the macrocystidia reported in the original description. Only with difficulty have confirmed the synonymy with *L. subvelutinus*. Our study of Peck's type revealed that the gills were little spaced indeed, but in all other respects the exsiccatum is like the ones ascribed to *L. hygrophoroides.* On the other hand the description by PECK (1904) and HESLER & SMITH (1979), point out that the difference in gill-spacing is the single character separating the two species. It was the microscopic identity of the two types which allowed synonymy between the two entities, in particular S.E.M. samples of the spores revealed the same ornamentation and their statistically-processed size overlapped perfectly. It is our opinion that the difference in gill-spacing could be a consequence of the condition of early developpemental stages of sporophores.

LACTARIUS CLARKEI Cleland 1927, Trans. R. Soc. S. Austr., **51**: 302.
Etymology: from proper noun. Named after Miss Phyllis Clarke.
Iconography: Cleland, 6.
Illustrations: fig. 7.
Pileus 5-8-(12.5) cm wide, convex, then plane and depressed at centre, sometimes funnel-shaped, buff-ochre with orange and cinnamon shades, dry, tomentose-shaggy. Lamellae adnate-subdecurrent, white to pale cream colour, suffused with brown, narrow, medium crowded, at times forked near stipe. Stipe 2-3-(5) cm long, 1.5-2.5 cm thick, paler than pileus, short, equal, tapering at base, dry, velutinous to tomentose. Context white, becoming slowly brown, taste mild, with $FeSO_4$ rapidly green-grey; latex white, mild. Spores ellipsoid, (7.5)8.7-9.9(10.5)x(6.6)6.8-7.2(7.5) /um, vol. 227.7 /um^3, Q = 1.33, warts neither very high nor marked, isolated or rarely connected by a few short, thin lines; spore print white. Basidia 4-spored, 50-60x8-11 /um with internal granulations not conspicuous. Pileipellis with a layer of roundish cells giving rise to a great number of long and crowded hairs, 50-60 /um long and 8-11 /um thick, septate, with thin or thick walls.
Habitat and distribution: terrestrial, solitary or occasionally gregarious, under *Leptospermum*; Australia and New Zealand.
TYPE: J.B. Cleland, 16/6/1917, Australia (PC).
COLLECTIONS EXAMINED: **PC**: J.B. Cleland, 16/6/1917, Australia (typus). **PDD**: V.C. Haydon, 23/5/1974, New Zealand; R.F.R. McNabb 6/4/1967, New Zealand; R.F.R. McNabb 10/11/1971, New Zealand; G.J. Samuels, 23/5/1973, New Zealand; E.P. White 20/12/1969, New Zealand.

OBSERVATIONS: KUEHNER & ROMAGNESI (1953b), citing a report by Heim, regard *Lactarius clarkei* and *L. rugatus* K.& R. as probable synonyms. HEIM (1955) placed the two species into synonymy crediting both with reticulate spores, and consequently reports *L. clarkei* both from Australia and Europe. McNABB (1971) states that various topotype collections identified by Cleland as *Lactarius clarkei* should be attributed to two distinct species, one with warted and the other with reticulate spores which, according to the New Zealand author, would be the one accounted for by Heim. Type examination showed us spores plainly dotted and a pileal cuticle with clearly septate hairs which unmistakably identify Cleland's species. The problem posed by the reticulate-spored species remains. It might be likened to *L. rugatus* whose distribution would be extended to Australia as well. However, this possibility needs confirmation. SINGER (1975), based on CLELAND's descriptions (1927 and 1934), doubtfully placed this taxon in subsect. *Lactifluini* (Burl.) Singer of sect. *Dulces* Heim ex Singer. McNABB (1971) erected the new section *Tomentosi* which includes the new subsection *Clarkeini* and the subsection *Rubroviolascentini* Singer 1942, with *L. clarkei* and *L. rubroviolascens* Heim as the only species, based on pileal, thick-walled hairs. The peculiar characters of *L. rubroviolascens* (see excluded taxa), the presence of thick-walled hairs even in other species of the section and the great similarity in micro and field characters of *L. clarkei* with the *Lactifluus*, make us discard this solution.

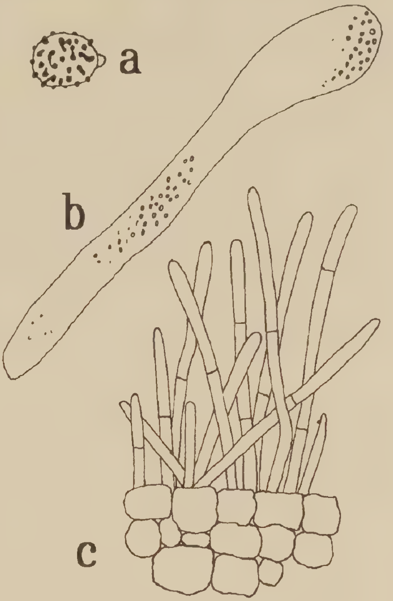

Fig. 7 - *Lactarius clarkei*: a) spore, b) cystidium, c) pileipellis structure.

LACTARIUS CLARKEI var. **AURANTIORUBER** McNabb 1971, New Zealand Journal of Botany, **9**: 60.
Etymology: lat., aurantius, a, um = having the colour of an orange; lat., ruber, rubra, rubrum = red.
Pileus 5.5-10 cm wide, centrally depressed when mature, brownish-orange or red-orange, paler in dry weather, orange-grey, pruinose to subtomentose. Lamellae adnate-subdecurrent, white to pale cream colour with pink shades, subdistant, at times forked near stipe. Stipe 2-5.5 cm long, 1-3 cm thick, same colour as pileus or slightly paler, equal or tapering at base, pruinose-subvelutinous. Context

pale orange-yellow, mild, with $FeSO_4$ green-grey; latex white. Spores ellipsoid, 8-10.5x6-7.5 /um, ornamentation of isolated warts; spore print white. Basidia 4-spored, 55-85x7-12.5 /um. Cystidia cylindrical-clavate, slightly differentiated, 42-130x3.5-7 /um. Pileipellis a layer of roundish cells bearing hairs up to 400 /um long and 3-6 /um wide, with thick walls.

Habitat and distribution: on the ground, gregarious under *Nothofagus*; New Zealand.

TYPE: R.F.R McNabb, 26381, 14-4-68, Springs Junction, New Zealand (PDD).

OBSERVATIONS: McNABB (1971) distinguished this variety by a series of characters which are constant in collections under *Nothofagus*, whilst the type from New Zealand grows exclusively under *Leptospermum*. The specimens under *Nothofagus* exhibit pilei with brighter orange colours and pruinose-subvelutinous instead of tomentose-shaggy, with hairs up to 150 /um long rather than up to 400 /um long, lamellae with pink shades and context pale orange-yellow. The epithet *aurantiorubra* with a feminine ending as used by its author, must be corrected to show concord with the masculine gender of the generic name, in compliance with the articles 24.2 and 32.5 of the ICBN (1983).

LACTARIUS PUTIDUS Pegler in Pegler & Fiard 1979, Kew Bulletin **33** (4): 620

Etymology: lat., putidus, a, um = stinking.

Iconography: Pegler & Fiard 10, b.

Illustrations: fig. 8.

Pileus 5.7-7.5 cm wide, convex to plane, depressed at centre, buff-brown, dry, finely velutinous, with strong wrinkles when mature. Lamellae decurrent, yellowish, staining brown, subdistant, seldom forked. Stipe 3-4 cm long, 0.8-1.4 cm thick, white later straw colour, staining dingy brown, equal or obconical. Context yellowish, dark brown on cutting, taste mild, odour disagreeable like rotten fish, with $FeSO_4$ immedi-

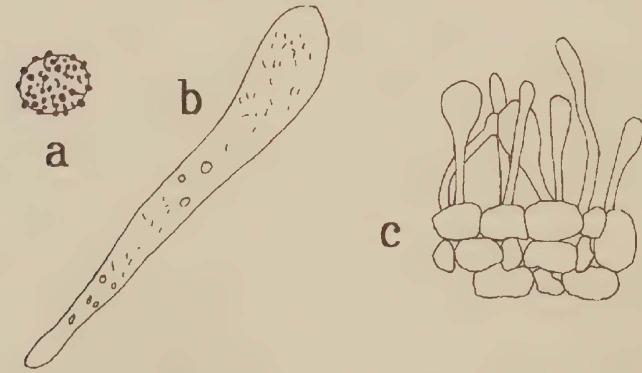

Fig. 8 - *Lactarius putidus:* a) spore, b) cystidium, d) pileipellis structure.

ately green grey; latex very copious, white-opalescent. Spores ellipsoid, (8.5)8.9-9.6(10.0)x(7.5)7.8-8.5(9.0) /um, vol. 306.7 /um^3, Q = 1.13, ornamentation of small and isolated warts, sometimes with short crests; spore print not indicated. Basidia 4-spored, 55-60x10-11 /um, sterigmata about 7 /um, content granular. Cystidia cylindrical-clavate, tapering at apex, 60-100x7-9 /um, with granular content. Pileipellis a layer of roundish cells and flexuose thin-walled hairs, vesciculous or capitate at apex, up to 13 /um long.

Habitat and distribution: on soil, in mesophytic forest, July-August; Martinique.

TYPE: J.P. Fiard, 625D, 4260/80-14, Martinique (K).

COLLECTIONS EXAMINED: **K:** J.P. Fiard 625 A, 4260/80-14, Martinique; J.P. Fiard 625 C,4260/80-14, Martinique; J.P. Fiard 625 D, 4260/80-14, Martinique(typus); J.P. Fiard 625 E, 4260/80-14, Martinique; D.N. Pegler 2819, 4260/80-15; D.N. Pegler 2918, 4260/80-15, Martinique.

OBSERVATIONS: Field characters viz dry velutinous pileus, context and lamellae staining brown, latex white and abudant, taste mild and smell of rotten fish, apparently impose its inclusion in sect. *Lactifluus*, but for this species in the same way as for *Lactarius caribaeus* Pegler's doubts arise because of the structure of the pileal cuticle. In fact it is made up of capitate and vesiculous hairs different from the ones of all other species, and its layer is not always clearly separated from the one of swollen cells.

LACTARIUS CARIBAEUS Pegler in Pegler & Fiard 1979, Kew Bulletin, **33** (4): 617

Etymology: from a geographical name, Caribees.

Iconography: Pegler & Fiard 10, g & h.

Illustrations: fig. 9.

Pileus 4-7.5 cm wide, plano-convex or depressed, then subinfundibuliform, pale ochre, with cinnamon stains, subvelutinous, dry. Lamellae clearly decur-

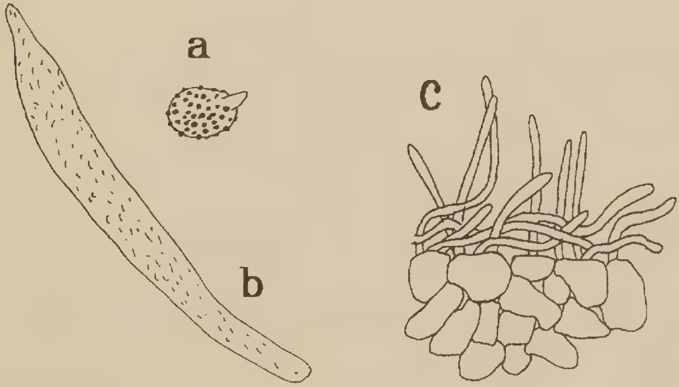

Fig. 9 - *Lactarius caribaeus:* a) spore, b) cystidium, c) pileipellis structure.

rent, cream colour, subdistant, occasionally anastomosing. Stipe 2-4 cm long, 1-2 cm thick, pure white, staining cinnamon on touching or with age, smooth. Context white, then staining cinnamon, taste mild, odour strong, disagreeable, nitrous, with $FeSO_4$ soon dark green; latex white, cinnamon on drying. Spores ellipsoid, (7.2)7.9-8.6(8.7)x(5.8)6.1-6.8(7.2) /um, vol.174.1 /um^3, Q = 1.28, ornamentation of isolated medium marked warts, at times with very short crests; spore print not indicated. Basidia 4-spored, 45-55x8-9 /um. Cystidia cylindrical-clavate, tapering at apex, sometimes digitate, 50-90x5-9 /um with granular-vermiform content. Pileipellis a lower layer of roundish cells bearing an upper one composed of thin-walled hairs tangled to form a trichodermium parallel to the pileal surface before turning upwards.
Habitat and distribution: on the ground, in xerophytic forest, September to December; Martinique.
TYPE: J.P. Fiard 818A, 4260/80-12, Martinique (K).
COLLECTIONS EXAMINED: **K**: J.P. Fiard 818 A, 4260/80-12, Martinique (typus); J.P. Fiard 827 A, 4260/80-13, Martinique; J.P. Fiard 827 B, 4260/80-13,Martinique; J.P. Fiard 842 A, 4260/80-12, Martinique; D.N. Pegler2822, 4260/80-13, Martinique.

OBSERVATIONS: PEGLER & FIARD (1979) place this entity in sect. *Dulces* Heim ex Singer subsect. *Lactifluini* (Burl.) Singer for "the pale lamellae, the subvelutinate pileal surface which lacks a virescens- structure, the heterotropic spores, and the mild taste". However, there is room for doubt on placing it in sect. *Lactifluus*, as we define it. The stature, velutinate pileus, mild taste, staining of context and spore ornamentation are characters which suggest a close affinity to *Lactarius luteolus* Peck but the structure of pileal cuticle is a little different from the one typical in the species of this section. The hairs which rise from the layer of roundish cells, before turning upwards, tangle in fact into a rather clear cut trichodermium, parallel to the pileal surface.

LACTARIUS LUTEOLUS Peck 1896, Bull. Torrey Bot. Club, **23**: 412.
Lactarius foetidus Peck 1902, Ann. Rep. N.Y. State Mus., **54**: 949. 33
Lactaria luteola Peck, Burlingham 1908, Mem. Torrey Bot. Club, **14** (1): 95.
Lactarius volemus var. *albus* Maire 1937, Fungi maroccani, 9.
Lactaria praeseriflua Murrill 1938, Mycologia, **30**: 361.
Lactarius scoticus Bk. & Br. sensu Romagnesi 1956, Bull. Soc. Mycol. Fr., **72**: 333-335.
Lactarius echinatus Thiers 1957, Mycologia, **49**: 716.
Lactarius brunneoviolascens Bon 1970, Doc. Mycol., **2**: 45-48.
Lactarius kuhnerianus Malençon 1974, Bull. Soc. Linn. Lion, **43**, special number, 245-252.
Lactarius luteolus f. *euluteolus* Bertault 1980, Bull. Soc. Myc. Fr., **96** (3): 285-86.
Lactarius luteolus f. *kuhnerianus* (Malençon) Bertault 1980, Bull. Soc, Myc. Fr., **96** (3): 285-86.
Etymology: lat., luteolus, a, um = yellowish.

Iconography: Bertault 216; Boll. gr. mic. Bres. **20**: 24; Cetto 1054; Hesler & Smith 30; Marchand 507; Peck (1903) 83, 7-11.
Illustrations: fig. 10, pl. 2c.
Pileus 3-7-(12) cm wide, convex, then applanate, slightly depressed at centre, off-white with straw-yellow tint, staining brown when touched or with age, dry, tomentose. Lamellae adnate, white then straw-yellow, bruising brown, medium broad, rather crowded, at times forked near stipe. Stipe 3-6 cm long, 1-2.5 cm thick, white to off-white, staining brown when touched, equal tapering at base, pruinose-velvety, dry. Context whitish, grey-brown when broken, taste mild, odour almost the same as in *L. volemus* but less strong, $FeSO_4$ gives a clear blue-green reaction; latex copious, white or whey-like with white flocci in suspension, mild. Spores ellipsoid, (6.7)7.0-8.2(8.6)x(5.0)5.2-6.0(6.5) /um, vol.120.1 /um^3, Q = 1.36, with isolated warts or rarely connected into short segments; spore print white to cream. Basidia 4-spored, 55-60x9-11 /um. Pleurocystidia cylindrical, with rounded apex, septate and clamped, at times branched, in thick palisade, 30-40 /um long and 6-7 /um wide. Cheilocystidia hair-like, flexuous with thin or moderately thick walls, 40-70 /um long and 2.5-4 /um wide, often capitate. Pileipellis a layer of roundish cells bearing hairs up to 70 /um long and 4-5 /um.
Habitat and distribution: on soil, in the plane in deciduous woods, especially oak, June to November; United States, Italy, France, Spain, Algeria, Marocco and Japan.
TYPE: Webster, East Milton, Massachussetts, USA (NYS).

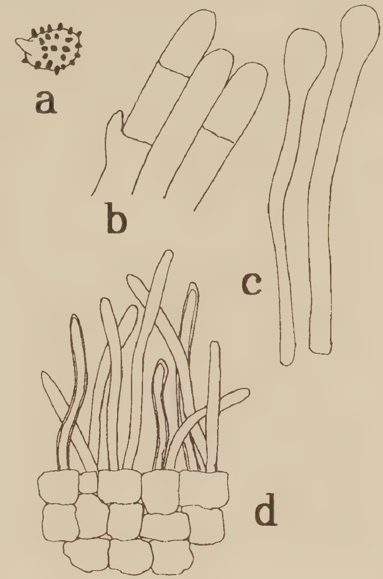

Fig. 10 - *Lactarius luteolus*: a) spore, b) pleurocystidia, c) cheilocystidia, d) pileipellis structure.

COLLECTIONS EXAMINED: **AQUI**: G. Lalli, 3/11/1981, National Park of Circeo, Italy; G.Lalli, 11/11/1982, National Park of Circeo, Italy; G. Pacioni, 26/11/1981, Sardinia, Italy; G. Pacioni, 7/8/1983, Michigan, USA. **BCC**: Llistosella, 84-410, Spain. **FLAS**: W.A. Murrill, 16020, Gainesville, Florida, USA (isotypus of *L. prae*seriflua). **MICH**: H.C. Beardslee Jr., 20/11/1935, Florida, USA (as *Lactaria luteola*); R.G. Benedict, A 7348, Illinois, USA; G.S. Burlingham, august 1918, Vermont, USA (as *Lactaria luteola*); A.H. Smith,6804, Michigan, USA; A.H. Smith, 9651, Tennessee, USA; H.D. Thiers, 1700, Texas, USA (holotypus of *L. echinatus*). **MPU**: G. Malençon, 257, Mamora, Maroc (as *L. kuehneri*, typus of *L. kuehnerianus*); G. Malençon, 299, Mamora, Maroc (as *L. kuehneri*); G. Malençon, 4162, Mamora, Maroc (as *L. kuehneri*).

OBSERVATIONS: Species originally described by PECK (1896) from North America. According to HESLER & SMITH (1979) who examined their types, *Lactarius foetidus* and *Lactaria praeseriflua* are to be considered later synonymys. We think that *Lactarius echinatus,* also, should not be regarded as a separate entity because the latex, which THIERS (1957) defines acrid and disagreeable, is the single clashing character. A statistical comparison of spore size shows complete similarity. The remaining micro- and macroscopic characters perfectly agree. Moreover, to the best of our knowledge, this entity has been collected only once. Synonyms of *L. luteolus* are also two species collected in Europe: *L. scoticus* sensu Romagnesi e *L. brunneoviolascens*. The same entity was subsequently named *L. kuehnerianus* by MALENÇON (1974) who regards it as intermediate between *L. volemus* (Fr.) Fr. and *L. rugatus* K.& R. and reports it from Algeria, Marocco and Spain. Algerian and Maroccan collections of this fungus had been named *L. volemus* var. *albus* by MAIRE (1937). The microscopical examination has showed us an absolute identity of American and Mediterranean collections. BERTAULT (1978) points out its copious fruiting in Marocco as *L. kuehnerianus*, but later (1979) considers it a synonym of *L. luteolus* which in its turn is eventually split (1980) into two forms: *euluteolus*, American with yellow pileus and *kuehnerianus*, Mediterranean, with pure white pileus in young specimens. Our own findings from the National Park of Circeo and Sardinia never showed a pure white pileus, not even at the beginning of the development, on the other hand also American authors, like for example HESLER & SMITH (1979), credit *L. luteolus* with a pileus "white or whitish to buff". As the geographical separation no longer holds good Bertault's two form cannot be considered valid. Concerning Italy the taxon has already been reported from Lombardy on the Bollettino del Gruppo Micologico G. Bresadola (1977) as *L. kuehnerianus*, while Cetto (1979) reports it even from Canton Ticino in Switzerland. This entity fruits also in Japan as reported by HONGO (1960).

DOUBTFUL ENTITIES

LACTARIUS PRINCEPS Berkeley 1852.Hook. London Journ. Bot., **4**: 135.
Etymology: lat., princeps = prince.
Illustrations: fig. 11.
Pileus 10 cm across, irregular infundibuliform, dry, opaque, subfarinaceous, of a deep rich blood red. Gills moderately broad, very pale, but concolorous with stem, decurrent. Stem 9 cm high, more than an inch thick, straight, attenuated downwards, blunt, more tawny than the pileus, solid, white within, except towards the edges, odourless; latex white. spores globose or subglobose, (8.0)8.1-9.0(9.5) x(8.0)8.1-8.8(9.2) μm, vol. 304.4 μm^3, ornamentation in the form of a complete, wide-meshed reticulum, made up of medium marked or rarely thinner connecting lines; spore print not indicated. Basidia 4-spored, size not obtained. Cystidia numerous, 55-70x6-7 μm, with sharp tips and very thickwalls. Pileipellis a layer of roundish cells bearing short, thin-walled hairs, thick-walled pileocystidia present.
Habitat and distribution: in woods; India.

TYPE: J.M. Berkeley, 16, 4260/80-11, Kullung, Khassya, India (K).

COLLECTIONS EXAMINED: K: J.M. Berkeley, 12, 4260/80-11, Myrung, Khassya, India; J.M.Berkeley, 16, 4260/80-11, Kullung, Khassya, India (holotypus).

OBSERVATIONS: The above macroscopical account is drawn almost literally from BERKELEY's original description (1852), while the microscopical details are the result of our personal observation of two collections dating back to July 1850 from two different localities of Khassya, India. They are the ones cited by Berkeley in his work. We do not know of any other report on this species. Microscopically the two collections are identical, in confirmation of Berkeley's impression who had considered them probably the same notwithstanding the very poor condition of collection n.12. The poor state of the specimens did not allow us to study them thoroughly. The species is very similar to *Lactarius volemus* (Fr) Fr, but a few characters press us to regard it as distinct: the complete lack of smell, the colour of pileus (in Berkeley's latin diagnosis we have "sanguineo-rubro") and size and ornamentation of spores (slightly smaller and with wider meshes on average). However, the difference in spore size and ornamentation is truly slight and for what concerns the colour also *L. volemus* var. *oedematopus* Scop.: Fr. sometimes exhibits brown hues with reddish shades. Consequently there is still some doubt concerning the validity of this species and only further collections will answer the questions about its true identity.

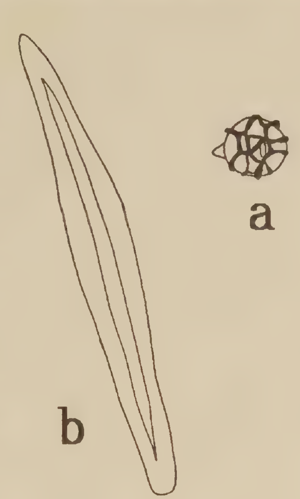

Fig 11 - *Lactarius princeps*: a) spore, b) cystidium.

LACTARIUS BRAUNII Rick 1930, Broteria, **24**: 118.

Etymology: from proper noun.

Pileus lemon yellow, granulose, with red spots, dry, brittle, 4 cm wide.Lamellae long decurrent, very spaced, ventricose, with serrate edge, fragile, concolorous. Stem white, tomentate towards apex, short, 3 cm long, thick. Latex white.Spores 7-8.2 x 5.5-7 /um, their ornamentation projecting 0.2-0.5/um, warty-reticulated, some spore with short ridges and catenulations; spore print not indicated. Basidia 4-spored, about 55x7 /um. Cystidia none seen except for inconspicuous cystidia at the edge of the lamellae, much like those of *Lactarius hygrophoroides* Berk. & Curt.. Epicutis of the pileus formed by slightly thick-walled, yellow hyphae forming a trichodermium; these hyphae are smooth, filamentous, with rounded tips and 2.5-4.5 /um diameter.Habitat and distribution: On the ground; Brazil.

TYPE: A.C.H. Braun 13751, Porto Alegre, Brazil (PACA).

OBSERVATIONS: We did not succeed in obtaining any specimen of this species in spite of Singer's personal accurate information on the location of the type. In dealing with this entity we have consequently to rely on the work by RICK (1930) from which the short account given above is derived. The microscopical characters are taken from SINGER (1953). His study is based on examination of the type which in exsiccate condition is said to be at first sight identifiable with *L. hygrophoroides*. Such an impression is confirmed by the similarity of the microscopical characters. The pileus and stipe colours in Rick's description, the probable absence of Fagales in the area where the type was collected (*L. hygrophoroides* grows mainly under *Quercus*) and finally Rick's reference also to *L. distans* Peck (a synonym of *L. hygrophoroides*) would suggest that the two entities are separate. Singer concludes by saying that only further collections of fresh material can clarify possible differences between *L. hygrophoroides* and *L. braunii*. Later SINGER *et al.* (1983), in a key to neotropical species of section *Dulces*, include also *L. braunii* without giving any comment.

LACTARIUS CALCEOLUS Berkeley 1847, London J. Bot., **6**: 315.
Etymology: lat. calceolus = tiny shoe.
Pileus 7.5 cm across, thin, arched so as to present a half-ovate form, brown-buff, smooth, not viscid; epidermis cracked, flesh white. Stem short, 1.3 cm in height and thickness, brown-buff, like the pileus. Gills white, decurrent, 1.3 cm broad, extremely distant, more or less connected by transverse veins or plates, forked near the edge, exuding a mild milky juice.
Habitat and distribution: On the ground in woods; United States (Ohio).
TYPE: T.C. Lea, 31 August and 10 September, Ohio, USA (K).
OBSERVATIONS: BERKELEY (1847), whose original description we have reported, defines this species "extremely singular", noteworthy for the very distant gills and the colour contrast between gills and stipe. Another feature which according to Berkeley contributes to make this entity unmistakable is the pileus laterally confluent. BURLINGHAM (1910) and HESLER & SMITH (1979) interpret this peculiar habit as an abnormality in the growth. Therefore, excluding lateral pileus and squat stipe as specific characters, BURLINGHAM (1908) arrived at the conclusion that *Lactarius calceolus* is the same as *L. hygrophoroides* Berk. & Curt. HESLER & SMITH (1979), who found it impossible to obtain sections of the pileus from the type, rank this entity among the doubtful species, but they declare for a conspecificity with *L. rugatus* K.& R. or *L. hygrophoroides* if ever it were to be recollected and exhaustively studied. We have not studied any collection of *L. calceolus* but, from the foregoing notes and on the basis of its gills being characterized as "extremely distant" and "intervenose", the synonymy with *L. hygrophoroides* appears probable. The impossibility of examining the type forces us to range this species among the doubtful ones, all the more so as a synonymization would bring about the priority of the epithet *calceolus* over *hygrophoroides*.

LACTARIUS LIVIDATUS Berk. & Curt. 1860, Proceedings of American Academy of Arts and Sciences, **4**: 1019.

Etymology: lat., lividatus, a, um = made to appear livid. Because of the colour of the gills.

Illustrations: fig. 12.

Pileus slightly depressed, fulvous. Lamellae narrow, quite serrate, dingy leather yellow then livid. Stem enlarged at the apex, fulvous. Spores elliptic, (7.0)8.1-9.0 x (6.5)6.9-7.5 /um, ornamentation consisting of lines of average thickness forming a more or less complete reticulum; spore print not indicated. Cystidia club-shaped, of the common type, small. Basidia not observed. Pileal cuticle not observed.

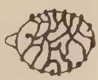

Fig. 12 - *Lactarius lividatus* : spore.

Habitat and distribution: on the ground; Japan.

TYPE: 4260/80-7, Japan (K).

COLLECTIONS EXAMINED: **K**: 4260/80-7, Japan (typus).

OBSERVATIONS: We could not observe the structure of the pileal cuticle because of the poor condition of the exsiccatum, spores and cystidia are of the same type as those of *Lactarius hygrophoroides* Berk. & Curt. BERKELEY & CURTIS (1860) conclude the short description of this fungus that we have reported by saying "has somewhat the habit of *L. volemus*". We do not have other characters available to arrive at a precise identification. It might be *L. hygrophoroides* or even a good species in its own right, but its position in the section is doubtful, supported only by the resemblance with *L. volemus* (Fr.) Fr. New collections are needed in order to reach a final conclusion.

LACTARIUS PURGATORII Singer 1948, Sydowia, **2**: 42 (ad interim).

Etymology: from geographical name, Purgatory Swamp.

A *Lactario hygrophoroide*, cui proximus, differt carne oleo anilinico reactionem rubram et $FeSO_4$ reactionem constantem viridem subeunte et autoxydatione brunnescente Lactarii volemi modo. Ab hoc lamellis distantibus differt. Sub quercubus et pinibus in palude "Purgatory Swamp" prope Norwood, Massachusetts, USA.

TYPE: R. Singer, July 1941, Purgatory Swamp, Massachusetts, USA (FH).

OBSERVATIONS: SINGER's description (1948) states that *Lactarius purgatorii* bears a strong resemblance to *L. hygrophoroides* Berk. & Curt. from which differs only by the flesh reacting red with anilin oil and green with $FeSO_4$ and by the brown staining pattern. The short Latin diagnosis lacks, in addition, data about microscopical characters.. Singer (pers. comm.) says that probably *L. purgatorii* has been identified by HESLER & SMITH (1979) as a variety of *L. hygrophoroides*. Subsequently SINGER *et al.* (1983) considered it synonymous whith *L. austrovolemus* Hongo, of the group with sphaerical, reticulated spores, but no microscopical comparison is cited in support of this hypothesis. The impossibility of examining the type prevented us from confirming this synonymy.

EXCLUDED SPECIES

LACTARIUS ALLOCHROUS Singer 1948, Sydowia, **2**: 41. 33
Etymology: gr., allokhroos = which takes another colour.
Illustrations: fig.13.
Pileus 5-12 cm wide, convex-depressed, brown with olive shades, finely velvety. Lamellae subdecurrent, whitish, at times intervenose, distant. Stipe 2-5 cm long, up to 2.5 cm thick, equal, olive-brown,glabrous. Context white, unchanging or changing to brown; latex white,mild. Spores ellipsoid, (9.1)9.8-11.4(12.4)x(7.4)7.8-9.0(9.8) µm, vol. 379.2 µm^3, with more or less marked warts rarely connected by some thin lines; spore print not indicated. Basidia 4-spored, 70-80x10-11 µm. Cystidia fusoid with rounded apex, 90-120x8-9 µm with granular-vermiform content. Pileipellis consisting of a trichodermium of hairs about 4 µm wide on a lower layer of more compact hyphae.
Habitat and distribution: on soil, under oak; United States (Florida).
TYPE: R. Singer, F 714, Florida, USA (F.H.).
COLLECTIONS EXAMINED: **F.H.**: R. Singer, 714, Florida, USA (typus).
OBSERVATIONS: SINGER (1948) states that this entity is in every respect close to *Lactarius hygrophoroides* Berk. & Curt. and later SINGER (1975) placed it in subsection *Lactifluini* (Burl.) Singer of section *Dulces* Heim ex Singer. Also HESLER & SMITH (1979) regard the two species as "closely related", but claim that *L. allochrous* Sing. is distinguished by the olive-brown colour and the wider spores in addition to the completely different structure of the pileal cuticle. On the grounds of this last feature they place *L. allochrous* Singer and *L. hygrophoroides* into two separate sections, section *Allardii* Hesler & Smith and section *Lactifluus* respectively. The study of the type revealed a cuticle with filamentous structure lacking roundish cells, which brings about the exclusion of this species from the section *Lactifluus* in our restricted sense.

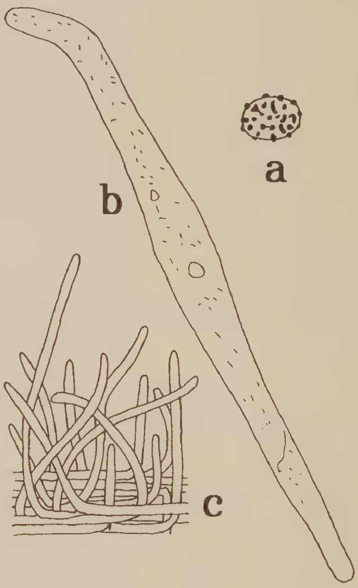

Fig. 13 - *Lactarius allochrous*: a) spore, b) cystidium, c) pileipellis structure.

LACTARIUS ANGUSTUS Heim & Gossens 1955, Bull. Jard. Bot. État, **25** (1): 67.
Etymology: lat., angustus, a, um = narrow. Because of the crowded gills.

Iconography: Heim (1955) 3, 3a & b.
Pileus 5-8 cm wide, plano-convex, later depressed at centre, bright reddish ochraceous, very finely velvety. Lamellae nearly free, white, close and narrow. Stipe 4-6.5 cm long, 1-1.8 cm thick, equal, slightly thickened at base, concolorous with pileus. Context white, becoming brown when exposed, taste at the same time acrid and bitter, odour fetid; latex white, very copious, peppery. Spores broadly ovoid to subglobose, 8-9x7.5-8.3 µm, with tuberculate warts rarely connected by thin trabeculae; sporeprint white.Basidia relatively long and gradually tapering towards base, size not indicated. Cystidia not differentiated. Pileipellis made up of erect, cylindrical or more or less ventricose hairs with rounded tips, rising from swollen or subglobose cells which may be likened to sphaerocysts, 10-20 µm wide.
Habitat and distribution: gregarious in dry forest, April; Zaire.
TYPE: Goossens Fontana, 713, avr. 1928, Binga, Belgian Congo (Herb. Heim).
OBSERVATIONS: We could not obtain any exsiccata of *Lactarius angustus*, as a consequence we rely for our considerations on the exhaustive description by HEIM (1955) who placed this taxon in the group *Volemi*. We are inclined to exclude this species from the section under study. The cuticle exhibits similar cells which are more elongated towards the surface, irregular in shape, originating directly from swollen cells; consequently it does not have the two distinct layers typical of the section. Moreover both the warty, subglobose spores and the peppery latex are incongruous to its definition.

LACTARIUS MARUIAENSIS McNabb 1971, New Zealand Journal of Botany, **9**: 54.
Etymology: from geographical name, Maruia.
Illustrations: fig. 14.
Pileus 7.5 cm wide, depressed at centre when mature, pale yellow or yellow, staining dark yellowish-brown, finely pruinose to subvelvety, slightly viscid in wet weather. Lamellae adnate to subdecurrent, pale cream colour with yellowish-brown edge, moderately distant. Stipe 4.5 cm long and 2.5 cm thick, almost equal, concolorous with the pileus, whitish at base, dry finely pruinose to velvety. Context white, taste mild, odour not peculiar, with $\mathrm{FeS0_4}$ rapidly salmon pink; latex white, unchangeable. Spores ellipsoid, (7.8)8.6-9.9(11.0)x(6.6)7.2-8.1(8.5) µm, vol.274.1 µm^3, ornamentation of crests forming an almost complete reticulum; spore print not obtained. Basidia 4-spored, 60-70x9-11.5 µm, hyaline or with hardly visible granular content, sterigmata 4-4.5 µm long. Cystidia cylindric-clavate, 45-60x7-9 µm, with thin walls and vermiform content. Pileipellis consisting of septate thin-walled hairs 4-6 µm wide, borne by an epithelium of small irregular cells; mucus also present.
Habitat and distribution: solitary under *Nothofagus*; New Zealand.
TYPE: R.F.R. McNabb, 26531, Maruia, New Zealand (PDD).
COLLECTIONS EXAMINED: **PDD**: R.F.R. McNabb, 26531, Maruia, New Zealand (isotypus).
OBSERVATIONS: McNABB (1971) states that his species may be included, even though with some difficulty, in section *Dulces* in the sense of Singer (1975). Pegler

& Fiard (1979) regard a similarity between McNabb's species and *Lactarius caribeus* Pegler as possible even though they separate *L. maruiaensis* on account of the reticulate spores and the cuticular septate hairs. The structure of the cuticle and the presence of mucus on the pileus, in agreement with McNabb's description who characterizes it as viscid in wet weather, are decisive as for its exclusion from section *Lactifluus.*

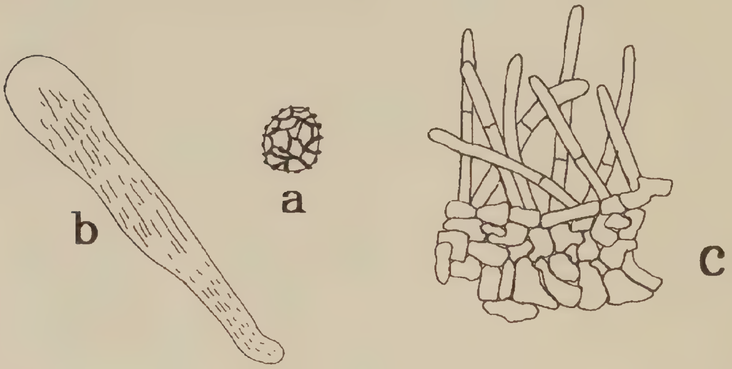

Fig. 14 - *Lactarius maruiaensis* : a) spore, b) cystidium, c) pileipellis structure.

LACTARIUS PEGLERI Pacioni & Lalli sp. nov.
Lactarius hygrophoroides Berkeley & Curtis sensu Pegler & Fiard 1979.
Etymology: from proper noun.
Iconography: Pegler & Fiard 10, e & f.
Illustrations: fig. 15, pl. 2d.

Fungus statura media. Pileo aurantiaco-ochraceo, depresso vel subinfundibuliformi, sicco, tomentoso, 2.5-5.7 cm lato, margine mox explanato. Lamellis alutaceis, distantibus, decurrentibus. Stipite ochraceo-incarnato, cilindrico, 2.5-3-8 cm longo, 0.6-1.2 cm crasso. Carne pallida, immutabile, odore non peculiari; latice albo, dulci. Sporis ellipsoideis, echinatis vel cristatis, (7.0)7.5-8.2(8.5)x(5.8)6.1-6.9(7.2) /um; cystidiis anguste clavaeformibus; epicute trichodermiali, hyphis 3-5 /um crassis. Habitat in xerophyticis silvis, sub *Coccoloba pubescens*. Holotypus ex Martinica, prope La Caravelle collectus, oct. 1977, Pegler legit, in kewensis herbario servatus. Species *Lactario hygrophoroidi* relata, sed epicutis structura et fere solitariis sporarum verrucis certe distincta est.

We give the description by Pegler & Fiard:"Pileus 2.5-5.7 cm diam., fleshy subglobose to convex then expanding, depressed to subinfundibuliform; surface brownish orange, 'Grenadine' (M. 10R/6.7/10.5) to 'Ochraceous-Tawny' (M.7.5YR/5.5/6.7) or 'Ochraceous-Salmon' (M. 4YR/7.0/7.5), finally fading to 'Salmon Color' (M. 4YR/7.1/5.5) to 'Flesh Color' (M.1YR/7.0/6.0), dry, finely tomentose to velutinate, smooth or rugose particularly towards the margin, azonate; margin obtuse, entire, regular, somewhat plicate-sulcate, at first involute. Lamellae adnatae-decurrent to deeply decurrent, 'Cartridge Buff'(M. 2.5Y/8.8/2.0) to 'Creamy Buff' (M. 2.5Y/8.0/4.5), finally'Chamois' (M. 2.5Y/7.0/6.0), thick 5-6 mm wide, rather distant, intermixted with lamellulae of two lengths. Stipe 2.5-3.8 cm x 6-12 mm, robust, cylindric, solid; 'Light Ochraceous Salmon' (M. 5YR/7.7/3.0) becoming 'Strontian Yellow'(M. 7.5Y/8.0/9.0) at the base, finely pruinose. Context 4-7 mm thick at the disk but much thinner at the margin, whitish to pale yellowish, unchanging, heteromerus, of thin walled, narrow hyphae, 2-5 /um diam., groups of sphaerocytes,7-24 /um diam., and scattered laticiferous elements, 5-9 /um diam.; odour not distinctive; taste mild. Latex abundant, pure white, unchanging. Spores 7-8.5x6-7 (8 + 0.38x6.64 + 0.36) /um, Q = 1.20, subglobose to short ellipsoid, hyaline, with an amyloid ornamentation of numerous, small verrucae, 0.2-0.4 /um high, occasionally linked into small groups by short connectives; suprahilar plage depressed, inamyloid, smooth, poorly delimited; hilar appendix small, 0.6-1.3x0.5-0.8 /um. Basidia 48-60x8-9 /um, elongate clavate, bearing four sterigmata, up to 8 /um long. Lamella-edge sterile, with crowded cheilocystidia. Cheilocystidia 20-30x2.5-5 /um, cylindric with obtuse apex, hyaline, thin-walled, resembling elements of the pileipellis. Pseudocystidia abundant, 65-85x5-6.5 /um, cylindric to narrowly clavate, with obtusely rounded apex, subhyaline with somewhat refractive contents, thin walled, not staining in sulphovanillin. Hymenophoral trama intermixed and interwoven, with numerous laticiferous elements and narrowed hyphae, but lacking sphaerocytes. Subhymenial layer well delopped, pseudoparenchymatous, 35-40 /um wide. Pileipellis a compact trichodermial palisade borne on a well developped hypodermium. Trichodermial palisade 55-75 /um thick, of hyaline thin-walled, cylindric elements 20-50x3-5 /um, with obtusely rounded apices, lacking dermatocystidia. Hypodermium 35-50 /um thick, of tightly interwoven hyphae with short, almost isodiametric elements. Chemical tests on the stipe: tincture of gaiac-positive, green; ferrous sulphate-negative."

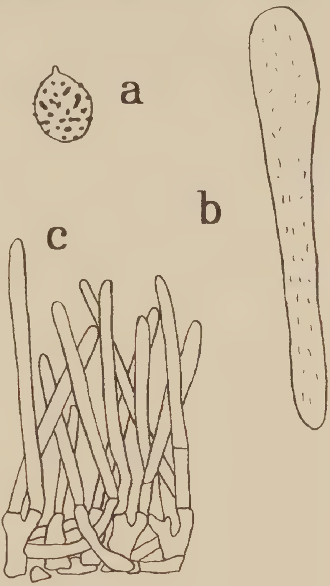

Fig. 15 - *Lactarius pegleri:* a) spore, b) cystidium, c) pileipellis structure.

Habitat and distribution: on soil in secondary xerophytic forest, at the base of *Coccoloba pubescens*, October-December; Martinique.

TYPE: D.N. Pegler 2924, 4260/80-8, Martinique (K).

COLLECTIONS EXAMINED: K: J.P. Fiard 821 A, 4260/80-8, Martinique; J.P. Fiard 821 B, 4260/80-8, Martinique; D.N. Pegler 2924, 4260/80-8, Martinique (typus).

OBSERVATIONS: The examination of three collections of *Lactarius hygrophoroides* from Martinique, showed us a perfect agreement of field characters, colour and tomentosity of cuticle, gill spacing and stature, but a surely different microscopy. The spores (our measures are (7.0)7.5-8.2(8.5)x(5.8)6.1-6.9(7.2) /um, vol. 167.9 /um, Q = 1.20) are similar to those of *L. hygrophoroides*, but slightly shorter and smaller, with an ornamentation made up of warts and short ridges, more like to that of *L. luteolus* Peck and, above all, the pileal cuticle lacks the layer of roundish cells completely, being exclusively composed of a rather dense trichodermium. These same microscopic characters are reported by PEGLER & FIARD (1979) in the description and drawings of their collections from Martinique. There is all evidence that we are faced with a perfectly distinct entity which is to be accommodated in section *Allardii* Hesler & Smith 1979, the closest to section *Lactifluus*. No species among those belonging in this section is a match of the one under scrutiny, accordingly we have thought it proper to propose it as a new species.

LACTARIUS PERVELUTINUS Hesler & Smith 1979, North American Species of *Lactarius*, 170.

Etymology: lat., per, prefix forming superlatives; late latin,velutum = velvet. Very velvety.

Iconography: Hesler & Smith 32.

Illustrations: fig. 16.

Pileus 4-4.5 cm wide, convex-depressed, ferruginous brown to reddish orange, ochraceous at margin, dry, velvety. Lamellae broadly adnate, cream colour, later staining slowly and slightly vinaceous-pink to lilac brown due to latex, subdistant. Stipe 3 cm long, 1.8 cm thick, equal, pale cream, more or less concolorous with the gills, dry. Context yellowish white, taste mild, odour slight, slowly green-grey with $FeS0_4$; latex white, becoming yellow on paper. Spores broadly ellipsoid, (6.5)6.9-8.1(8.8) x (4.8)5.1-5.7(6.0) /um, vol. 109.3 /um^3, ornamentation made up of crests and warts at times connected into a broken reticulum, looking mostly dotted; spore print creamy-

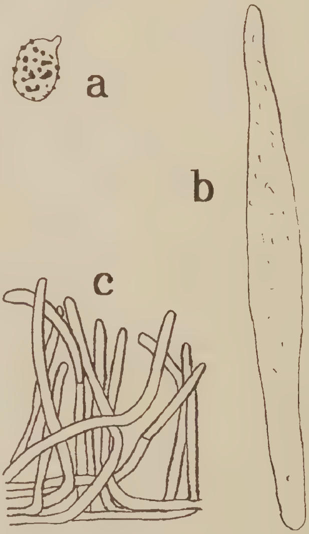

Fig. 16 - *Lactarius pervelutinus*: a) spore.

white. Basidia 4-spored, 40-50x6-8 /um. Cystidia subfilamentous or narrowly fusoid ventricose, 26-40x3-8 /um. Pileipellis filamentous, a trichodermium of thickly woven hairs becoming parallel at the surface.

Habitat and distribution: on soil, under broad-leaved trees; United States (Michigan).

TYPE: A.H. Smith, 84431, Michigan, USA (MICH)

COLLECTIONS EXAMINED: **MICH**: A.H. Smith, 84431, Michigan, USA (holotypus).

OBSERVATIONS: Species recently erected by HESLER & SMITH (1979), who place it in the group of *Lactarius hygrophoroides* Berk & Curt. It is recognized by the small-sized spores (the smallest in the section), latex turning yellow on paper and the green reaction of flesh with $FeSO_4$. The structure of the cuticle, as we were able to observe when examining the type, forces us into excluding this species from the section. We think that the species should be placed in section *Allardii* Hesler & Smith, in close proximity to *L. allochrous* Singer which has the same type of cuticle and spores with the same ornamentation, even though larger.

LACTARIUS PSEUDOVOLEMUS Heim 1938 Candollea, **7**: 378.

Etymology: gr., pseudos = false. Likely to confuse with *L.volemus*.

Illustrations: fig. 17.

Pileus 5-6 cm wide, convex, then deeply depressed at centre, red brown at disc, orange brown elsewhere, dry, minutely tomentose-granulose. Lamellae arcuate-decurrent, light orange, narrow. Stipe 3-3.5 cm long, 0.8-0.9 cm thick, equal, orange brown, slightly paler than pileus, minutely tomentose-granulose. Context cream colour, odour and taste none; latex white, copious, slightly astringent. Spores subglobose, (7.5)7.6-8.2(8.5)x(6.5)6.7-7.5(8.0) /um, vol.201.7 /um^3, ornamentation of warts and short crests connected by thinner lines; spore print white. Basidia 4-spored, 40-45 /um long and 10-11 /um wide. Cystidia clavata or lanceolate-clavate, at times digitate at apex 60-80x8-10 /um, with granular-vermiform content. Pileipellis a turf of thick-walled, often branched hairs up to 150 /um long and about 4.5 /um wide, rising from a compact layer of interwoven hyphae. Habitat and distribution: on soil, isolated; Madagascar.

TYPE: R. Heim, G. 61, Madagascar, 7/12/1934 (PC).

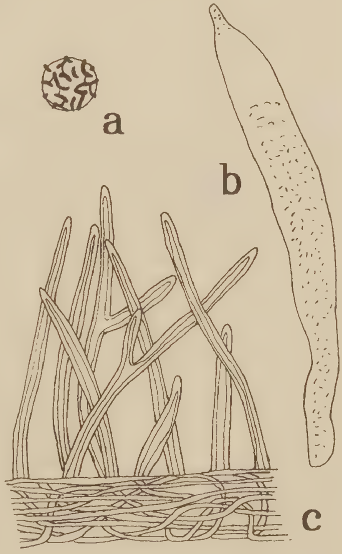

Fig. 17 - *Lactarius pseudovolemus*: a) spore, b) cystidium, c) pileipellis structure.

COLLECTIONS EXAMINATED: **PC**: R. Heim, G. 61, Madagascar, 7/12/1934 (typus).

OBSERVATIONS: The unchangeable context, the slightly astringent latex and the cuticle structure are characters which prevent this species from being included in the section under study. Our own microscopical observations carried out on the type are partly at variance with HEIM's (1937), who does not report thick-walled elements in the cuticle. HEIM (1937) places this entity in section *Dulces*, along with *Lactarius rubroviolascens*, and later (HEIM, 1955) in the *volemi* group. It should be noted that the French author published the descriptions of this and of *L. rubroviolascens* in 1937 and the Latin diagnoses in 1938.

LACTARIUS RUBROVIOLASCENS Heim 1938, Candollea, **7:** 377.

Etymology: lat., ruber, rubra, rubrum = red; lat., viola = violet. Due to the colour-change of context and gills alike.

Iconography: Heim (1937) 1,C.

Illustrations: fig. 18.

Pileus 6-8 cm wide, convex-deformed, irregular, ochre-brown with orange shades, dry, wholly tomentose, with thick cuticle, easily peelable. Lamellae adnate, cream colour, blackening then becoming violet blue, broad, not very crowded. Stipe about 4 cm long, 1.8-2 cm thick, orange at apex, lighter in the middle, orange red-brown towards base, white and tomentose at base, completely and minutely velvety. Context white, slowly blackening in the pileus then becoming red ,unchangeable in the stipe, tasteless and odourless, pink with agreen ring with FeSO4; latex copious, whey-like, light pinkish-grey, mild. Spores broadly reniform obovoid, (7.0)8.5-9.7(10.0)x(6.2)6.5-7.1(7.5) µm, vol.210.9 µm^3, ornamentation in the form of fine-dot-like warts; spore print white. Basidia 4-spored, 48-54x9-10.5 µm, sterigmata about 6 µm long. Cystidia elongated rhombic, up to 160 µm long and 14 µm wide,with very thick walls. Pileipellis made up of hairs 4-8 µm wide, cylindrical, here and there constricted, often sinuous, with rare septations, at times with swollen tips, with thick walls, rising from a layer of binding hyphae which sit on a zone of broader often allantoid cells.

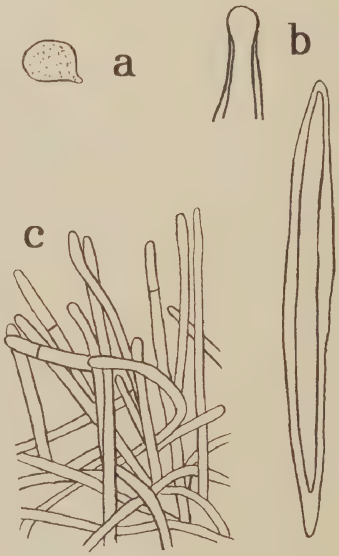

Fig. 18 - *Lactarius rubroviolascens*: a) spore, b) cystidium, c) pileipellis structure.

Habitat and distribution: on the ground, in small groups or solitary; Madagascar.

TYPE: R. Heim, G.85, Madagascar, 9/12/1934 (PC).

COLLECTIONS EXAMINED: PC.: R. Heim, G.85, Madagascar, 9/12/1934 (typus).

OBSERVATIONS: The context slowly becoming black then red, the light pinkish-grey whey-like latex and above all the filamentous structure of the cuticle which is also easily separable and tomentose, strongly suggest excluding this species from section *Lactifluus* in spite of the presence of very thick-walled hymenial cystidia much resembling those of *Lactarius volemus* (Fr) Fr.. The problem posed by tropical Lactarii is very complex. Nearly always the species cannot be inserted in the traditional groups and are often intermediate between two of them.The existence of species with remarkably visible velar remnants or having a lignicolous habitat as well as the exsistence of species exhibiting quite a few characters intergrading with the genus *Russula*, especially with section *Compactae*, raises a series of questions the answers to which might shed new light on *Lactarius* phylogenesis. HEIM (1937,1955) has included the species from the tropics in the taxonomy of Lactarii which, according to him, is closely related to that of *Russula*. In any case he regards it as provisional on account of its being founded on practical rather than natural principles.

CONCLUSIONS

In our study we have examined 171 exsiccata of 27 different taxa which, in the light of the literature we have consulted, belong in sect. *Lactifluus* or have some affinity with it. The investigation was intended, above all, to highlight the structure of the pileipellis, a key sectional character, as well as that of the hymenium. Spore size, in particular, has been assessed statistically, accordingly, in the data reported, in addition to the highest and lowest values in parenthesis, the mean value plus or minus the standard deviation is given. Other sporal parameters accounted for are volume and Q value (ratio between length and width). Further examinations have been carried out by means of a scanning electron microscope, which proved invaluable to the comparison of spore ornamentation. The twenty-seven taxa investigated did not always exhibit microscopical characters perfectly in agreement with the restricted conception of section *Lactifluus* as understood by us. Some of these had been placed by other authors in this same group but it was meant in a broader sense, as a consequence we have had to exclude six species: *Lactarius allochrous*, *L. angustus*, *L. maruiaensis*, *L. pervelutinus*, *L. pseudovolemus* and *L. rubroviolascens*. A seventh species, *L. pegleri*, described as new by us on the basis of some atypical collection of *L. hygrophoroides*, is to be included in the close section *Allardii*. Such a conclusion rests mainly upon the nature of the cuticle structure which in the excluded species does not fit in with the pattern typical in the section, i.e. a clear-cut layer of roundish cells bearing numerous hairs with an anticlinal orientation. Five more species, *L. princeps*, *L. braunii*, *L. calceolus*, *L. lividatus* and *L. purgatorii* may only doubtfully be included in the section, not so much for real inconsistencies in the field characters reported in the original descriptions or in the microscopical ones observed by us as for the fact that they probably have to be reduced to synonymy under other taxa of the same section. Unfortunately one goes to great pains to acquire certainty about these synonymies either for lack of exhaustive original descriptions, or for the poor condition of type specimens which do not allow a conclusive study or, finally, also because the species dating from last century are unreported since their publication. Only additional topotype collections might prove crucial to a final clarification. Leaving on one side the excluded and doubtful species we recognize in sect. *Lactifluus* nine species and three varieties among those as yet described from all over the world. The macroscopical and microscopical characters are homogeneous enough, but there is no shortage of differencies, on the contrary, especially in the tropical and neo-tropical species these are so remarkable that they occupy a rather peripheral position in the section. In any case, it is apparent that all species in the section share a common pattern of basic morphological features, and that they fall naturally into three groups. This subdivision was arrived at taking into account macro and micro-characters alike, both processed with statistic and cladistic methods. Three species and two varieties belong in the first group: *L. volemus*, *L. volemus* var. *oedematopus*, *L. volemus* var. *flavus*, *L. corrugis* and *L. austrovolemus*. These entities have a great likeness in habitus and colour pattern and, what is more, exhibit almost identical microscopic structures. The spores are globose or subglobose, with an ornamentation in the form of a marked and complete reticulum and the cystidia, especially peculiar, numerous and obvious, are lanceolate and very thick-walled. The second group is characterized by spores elongated and ornamented with isolated spines or warts; colours are generally light, off-white to yellowish or ochre, rarely with some shade of brown. In this group we have included three species: *L. caribaeus*, *L. putidus* and *L. luteolus*. It is a far less homogeonus group than the previous one, in fact in this case the hymenial cystidia are rather variable and moreover the two neotropical species *L. caribaeus* and *L. putidus* reveal a cuticle structure slightly differing from the typical one. The third group encompasses three species, *L. hygrophoroides*, *L. rugatus*, *L. clarkei* and one variety, *L. clarkei* var. *aurantiorubra*. The spores are of the elongate type as in the second group, but bearing an ornament consisting of an almost complete reticulum. From a microscopical view point the group is homogeneous enough, cuticle, spores and clavate cystidia are more or less the same as to structure and size, also the colour pattern is very similar, orange-brown often with some shade of brick-red. As to the statistical and information technology processes which have substantiated these subdivisions, we want to add that the mean volume has proved to be a datum particularly significant in all the programmes in which it was included. Most instrumental in our evaluating any possible specific identity, it was a confirmation in itself of the grouping hypotheses, except for the atypical tropical species and *L. corrugis*, which statistically is far removed from *L. volemus* and *L. austrovolemus*. In any case, the "Clinch, version 6.2 - 1984, by K. L. Fiala", a Fortran program for cladistic inference by compatibility of hypothesized character state trees, has turned out the most complete; processing a number of characters it has given the following phylogenetic tree:

```
      *---caribaeus
      *
---luteolus
      *
      *      *---putidus
      *      *
      *------hypothetical 1
             *
             *      *---clarkei
             *      *
             *      *      *---rugatus
             *      *      *
             *      *---hygrophoroides
             *      *
             *------hypothetical 2
                    *
                    *      *---austrovolemus
                    *      *
                    *------hypothetical 3
                           *
                           *      *---corrugis
                           *      *
                           *---volemus
```

The "Conphen, version 2.0 - 1990, by G. F. Estabrook", a program to create evolutionary classifications, with classes monophyletic on a specified phylogenetic tree, using convex phenetix, on the basis of the same characters and data, quantifies the distances among the species which, as a result, are subdivided into the same three groups as hypothesized on the grounds of morphological characters; consequently these groups should be natural:

```
                            ┌corrugis  0  0.000
                       ┌volemus  2  5.000
                  ┌hypothetical 3  1  91.000
                  │    └austrovolemus  0  0.000
            ┌hypothetical 2  3  36.000
            │     │    ┌rugatus  0  0.000
            │     ├hygrophoroides  4  6.000
            │     └clarkei  0  0.000
      ┌hypothetical 1  5  6.000
      │     └putidus  0  0.000
luteolus  0  0.000
      └caribaeus  0  0.000
```

The distance numerically most significant is between hypothetical 2 and hypothetical 3, the next between hypothetical 1 and hypothetical 2. The distances between the other phylogenetic branchings show much lower values. Hence, we think it proper to assign the groups subsectional rank, not so much for sistematic necessity as to stress the two outstanding jumps in the phylogenetic tree.

Subsectio *Luteoli* Pacioni & Lalli subsect. nov.:
pileus sine colore fulvo vel aurantiaco; sporae ellipsoideae, echinatae vel echinatae et cristis tenuibus praeditae; cystidia tenuitunicata, interdum capitulata; pili pileici interdum capitulati.
Typus: *Lactarius luteolus* Peck.

Subsectio *Rugati* Pacioni & Lalli subsect. nov.:
pileus cum colore fulvo vel aurantiaco; sporae ellipsoideae, reticulatae vel echinatae-cristatae; cystidia tenuitunicata, clavaeformia.
Typus: *Lactarius rugatus* Kuehner & Romagnesi.

Subsectio *Volemi* Pacioni & Lalli subsect. nov.:
pileus cum colore fulvo vel aurantiaco; sporae globosae, reticulatae; cystidia crasse tunicata, lanceolata..
Typus: *Lactarius volemus* (Fries) Fries.

As a conclusion we can add that the Section, with reference to its various species, has an almost world-wide distribution. Most species exhibit very similar characters while a few, especially those from the tropics, show remarkable variations in the structure. This phenomenon is observed also in other species and sections throughout the genus *Lactarius*. The placing of these entities often brings about great problems and brings into question the traditional taxonomic arrangement of the genus based as it is mainly on European and North-American species.

AKNOWLEDGEMENTS

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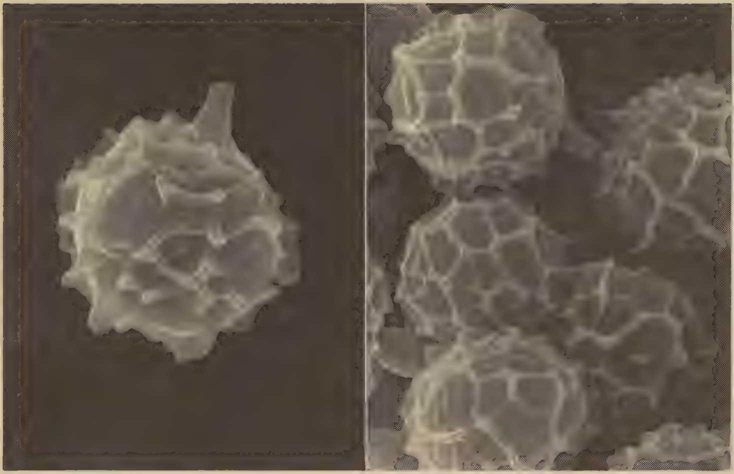
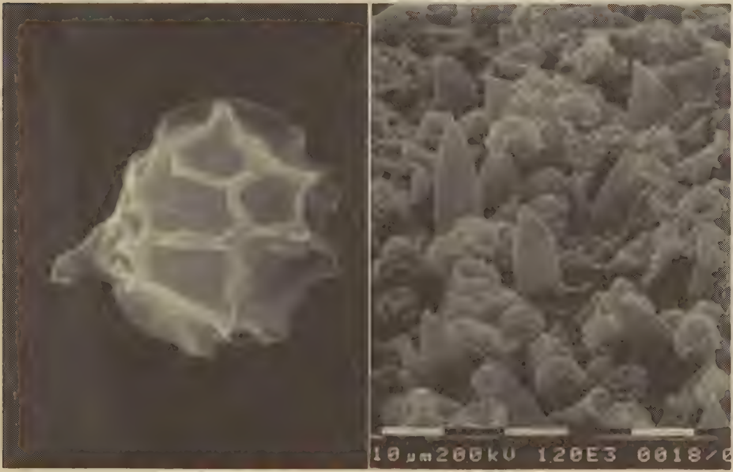


a) *Lactarius corrugis*: spore.   b) *Lactarius volemus*: spores.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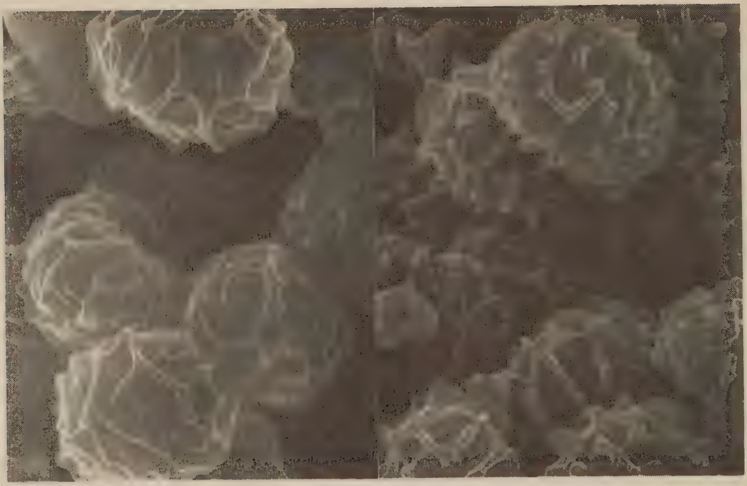
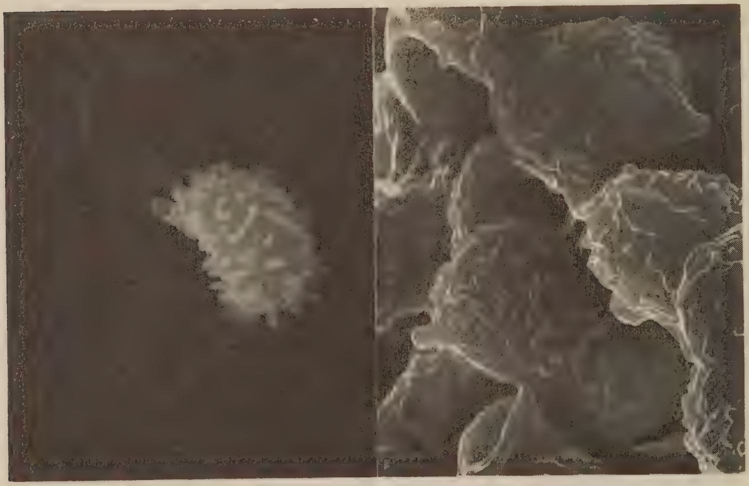
c) *Lactarius austrovolemus*: spore.   d) *Lactarius volemus*: cystidia (x900).

Plate 1: scanning electron micrographs (x 3.750).



a) *Lactarius rugatus*: spores. b) *Lactarius hygrophoroides*: spores.



c) *Lactarius luteolus*: spore. d) *Lactarius pegleri*: spores.

Plate 2: scanning electron micrographs (x 3.750).

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REEVALUATION OF REPORTS OF 15 UNCOMMON SPECIES OF CORTICIUM FROM CANADA AND THE UNITED STATES

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Abstract: - Fifteen species, most of which were treated in the 1926 monograph by E.A. Burt in the genus *Corticium*, have been reevaluated. Most of the specimens cited by Burt were restudied and many were found to have been misdetermined. Four fungi (*C. auberianum*, *C. debile*, *C. subcontinuum*, *C. subochraceum*) are extralimital and no longer considered as part of the mycoflora of Canada and the United States. The remaining eleven species are excluded from *Corticium*. New combinations proposed are: *Athelia maculare* (Lair), *Ceraceomyces subapiculatus* (Bres.), *Clavulicium venosum* (Berk. & Rav.), *Hyphoderma leptaleum* (Ellis & Ev.), *Hyphoderma rubropallens* (Schw.), and *Hypochnicium versatum* (Burt). Four names are placed in synonymy: *Corticium epigaeum* Ellis & Ev. is *Gloeocystidiellum lactescens*, *C. ochraceum* (Fr.) Fr. is *G. ochraceum*, *C. ravum* Burt is *G. karstenii*, and *C. rubrocanum* Thümen is *C. albido-carneum* (Schw.) Massee which is a *nomen dubium*.

In preparation for the publication of a synopsis of the corticioid fungi of North America (in press) disposition of a number of reported species could not be found in recent monographs. Fifteen of these are treated here. E.A. Burt (1926) recognized just over 100 species in his North American monograph of the genus *Corticium*. Most of these were reported from the United States and Canada. Subsequently the circumscription of the genus *Corticium* has been much reduced with the result that many species formerly in *Corticium* have been placed in other genera and the necessary new combinations proposed. Two studies have concentrated on revising the *Corticium* names treated by Burt (Liberta 1969, Rogers and Jackson 1943). However, types or vouchers for several species of *Corticium* have not been reevaluated and these fungi remain, perhaps misplaced, in *Corticium*.

The collections that Burt cited represent the known geographic distribution and substrate preferences for most of the species treated below. The type specimens and most other collections cited by Burt for these fungi have been restudied to determine whether the name should remain in *Corticium*, whether all specimens are conspecific, and to confirm the published distribution and substrate records.

Burt, for most of his career, worked at the Missouri Botanical Garden (MBG). However, the mycological collections, which he cited by MBG accession number are now housed at the National Fungus Collection, U.S. Department of Agriculture, Beltsville, Maryland (BPI). Burt's private herbarium, containing some type specimens and specimens he cited, is now at the Farlow Cryptogamic Herbarium, Cambridge, Massachusetts (FH).

METHODS

The standard mounting media for examination of specimens of the Corticiaceae were used, i.e., Melzer's reagent, 2% potassium hydroxide, cotton blue in lactic acid, and sulfobenzaldehyde. The formulae for these can be found in Boidin (1958), Hawksworth *et al.* (1983) and Hjortstam *et al.* (1987). The codes in parentheses represent colours from the *Munsell Book of Color* (Anon., 1929-1942). The abbreviations for herbaria where specimens examined are permanently housed are from Holmgren *et al.* (1990). The epithets are treated in alphabetical order.

RESULTS

***Corticium albido-carneum* (Schw.) Massee**

J. Linn. Soc., Bot. 27: 142, 1890.

Basionym: *Thelephora albido-carnea* Schw., Amer. Philos. Soc. Trans., n.s. 4: 169, 1832.

Citation of type: "*passim in cortice Vitis obvia*, Bethlehem", fide Schweinitz.

Basidiomes effuse, crustose, 45 x 15 mm and about 150 μm thick; hymenial surface smooth, dull, glabrous, pale brown with a greyish white bloom on the surface and heavily fissured into 1 x 1 mm frustules; subiculum yellow brown, firm; margin white, adnate, sparse, cottony, 1 mm wide.

Hyphal system monomitic; generative hyphae 3.0-4.0 (-5.0) µm diam, with clamp connections, the walls hyaline, thin, nonamyloid; cystidia (probably gloeocystidia) imbedded in the subiculum, cylindrical-clavate, sulfo-negative, 40 x 9 µm; botryose dendrophyses much branched with the ultimate branches 1 µm diam, projecting 5-10 µm, soluble in 2% KOH; hymenial layer of cylindrical-clavate immature basidia, 20 x 6 µm, neither mature basidia nor basidiospores seen.

The preceding description was taken from the neotype (PH). Specimens, presumably parts of the neotype, in the Michener Collection (BPI) and the Curtis Collection (FH) are the same fungus and they too are sterile.

Burt (1926:278) cited three collections, one each from Pennsylvania (the type), Michigan and Virginia. The Michigan and Virginia collections are not conspecific with the type collection. The Virginia collection matches the description published by Burt. It has simple-septate hyphae and broad vesicles 10-15 µm diam, but neither basidiospores nor mature basidia were seen. Another collection of this fungus from Maryland is also sterile. The Michigan collection is a third fungus, characterized by thick-walled subicular hyphae 2.0-3.5 µm diam with clamp connections and ellipsoid spores 10.5 x 5.5 µm, which was not further identified. The fact that all collections were from *Vitis* suggests that the mycoflora of corticioid fungi on that genus is varied and poorly known.

The name cannot be adequately characterized, because neither mature basidia nor basidiospores are known, and is declared a *nomen dubium*. *Corticium rubrocanum* is the same fungus and specimens of it are sterile also (see below).

Specimens examined: Maryland: Takoma Park, March 1900, on *Vitis* sp., C.L. Shear, det. D.P. Rogers (BPI 283839). Michigan: Paw Paw, 9 May 1908, on cultivated grape vine, L.A. Hawkins (FH). Pennsylvania: Bethlehem, on *Vitis* sp., ex Herb. Schweinitz, as *Thelephora albido-carnea* (PH herein designated neotype, presumed isotypes BPI: Michener Collection 15:17 and FH: Curtis Herb.).

Virginia: Arlington Farm, 28 Feb. 1915, on dead bark of grape, C.L. Shear 2810, MBG 15310 (BPI 283842).

Corticium auberianum Mont.
In: La Sagra, Hist. de Cuba 9 (2): 226, 1845.

Citation of type: "*Ad ramulos in Cuba insula prope* Alquizar *a cl. Auber inventum*", fide Montagne.

Burt (1926:199) cited ten collections from the United States. All have been studied by me. Both Arkansas collections are a *Peniophora* sp., the Florida collection is a *Phanerochaete* sp., the Georgia collection and the Louisiana collections, cited as Q and R, appear to be sterile specimens of a *Scytinostroma* sp., the North Carolina collection is a *Hyphoderma* sp., the South Carolina collection is a *Corticium sensu stricto* but no spores were seen, and the two Vermont collections are two species of *Grandinia.*

The heterogeneity of the specimens that Burt in some instances referred to one epithet has been reported by Rogers and Jackson (1943). They concluded that of 17 paratypes of *Corticium abeuns* Burt "only three resemble the type at all closely."

There is a packet (BPI 280382) which may contain part of the type, but the fungus has been almost entirely devoured by insects and could not be adequately characterized. Also three additional collections at BPI are labelled *C. auberianum.* One (BPI 280385) is *Phanerochaete velutina* (DC.:Fr.) Karst., the second (BPI 280387) is unknown to me and is sterile, and the third (BPI 280386) is unidentifiable due to its poor condition. Finally, the Bermuda collection, cited by Burt, is *Grandinia* sp. but the hymenium is poorly preserved.

I have not seen the type of *C. auberianum* at Kew, from Cuba, but the variety of species represented in the United States collections cited by Burt suggests that none may be conspecific with the type. Until the type has been adequately characterized, *C. auberianum* should not be considered as part of the mycoflora of the United States.

Specimens examined: Arkansas: Womble, W.H. Long, MBG 8633 (BPI 280388) and MBG 17801 (BPI 280389). Georgia: Tallulah Falls, A.B. Seymour, MBG 44595 (BPI 280381). Florida: Sands Key, R.A. Harper 6, MBG 54537 (BPI 280380). Louisiana: St. Martinville, 14 Mar. 1899, A.B. Langlois "R" (FH), near St. Martinville, 28 Nov. 1899, ABL "Q" (FH), presumably St. Martinville, ABL 2970 (BPI 280385), and ABL, s.n. (BPI 280387). North Carolina: Blowing Rock, on decayed, decorticated branches of a hardwood on the ground, G. Atkinson 4330 (BPI 280384, FH). Pennsylvania (presumably), on dead *Crataegus*, ex E. Michener, M.D., MBG 63748 (BPI 280386). South Carolina: Society Hill, Jan. 1848, M.A. Curtis 2497 (FH Burt Herb. and Curtis Herb.). Vermont: Middlebury, 23 Sept. 1898, E.A. Burt (FH) and Middlebury: Chipman's Hill, 13 Aug. 1896, EAB (FH). Bermuda: Walsingham, H.H. Whetzel, MBG 58718 (BPI 280390). Cuba, ex Montagne, ex Bresadola herbarium (BPI 280382).

Corticium debile Berk. & Curt. ex Massee
J. Linn. Soc., Bot. 27: 131, 1890.

Citation of type: "(Type in Herb. Berk. n. 4065). On wood. Venezuela; United States", fide Massee.

A presumed isotype lacks any structure. No details could be discerned. I have not seen specimens, if any exist, from Kew.

Burt (1926:274) cited three collections from the United States. The features of the California collection match Burt's description very closely. Burt did not describe the basidia, but I found them to be tremellaceous, and the collection to be *Basidiodendron eyrei* (Wakef.) Luck-Allen. One (BPI 281076) of the two Louisiana collections is *Cystostereum murraii* (Berk. & Curt.) Pouzar. I have not seen the other Louisiana collection which Burt cited as "Langlois, bb".

Until the features characterizing this name are clarified it should not be considered as part of the mycoflora of the United States.

Specimens examined: California: Palo Alto, 25 Nov. 1911, W.A. Murrill & L.S. Abrams 1195, MBG 55709 (BPI 281068). Louisiana: St. Martinville, 12 Jan. 1890, A.B. Langlois 2674, MBG 58327 (BPI 281076). Venezuela, coll. Fendler, (204) (presumed isotype FH).

Corticium epigaeum Ellis & Ev.
J. Mycol. 1: 88, 1885.

Citation of type: "Oregon: *Carpenter, 100,* type (in N.Y. Bot. Gard. Herb.)", fide Burt.

Basidiomes in pieces, about 20 x 20 mm; hymenial surface smooth to tuberculate, pallid, not cracked; margin white, appressed, to 5 mm wide.

Hyphal system monomitic; subicular hyphae distinct, woven, with clamp connections, 2.0-3.5 µm diam, the walls hyaline, thin, nonamyloid, acyanophilous; hyphidia numerous, vertically oriented, 2.4-3.4 µm diam, but the apical features obscure; gloeocystidia (Fig. 2) common, cylindrical, up to 120 x 7-12 µm, the contents granular in 2% KOH and in Melzer's, staining grey black in sulfobenzaldehyde, the walls hyaline, thin, smooth, nonamyloid, acyanophilous; basidia not found; basidiospores (Fig. 1) broadly ellipsoid to subglobose, 6.0-7.0 x 4.4-5.2 µm, the walls weakly amyloid, hyaline, smooth, acyanophilous, with a large, broad, blunt apiculum.

The tuberculate nature of the hymenial surface seemed to be caused by the irregular surface of the soil over which it grew. The basidiospores were scattered throughout the thickness of the basidiomes, suggesting that hymenial thickening had occurred progressively. The lack of cracks in the basidiome suggests it was a young specimen when collected.

This specimen is *Gloeocystidiellum lactescens* (Berk.) Boidin as described in Eriksson and Ryvarden (1975) and the name *Corticium epigaeum* is placed in synonymy. Burt (1926) cited the type and seven additional collections as *C. epigaeum*, but I have studied only the type.

Specimen examined: Oregon, on the ground over soil, July 1884, W.C. Carpenter, 100 (NY).

Hyphoderma leptaleum (Ellis & Ev.) Ginns, _comb. nov._
Basionym: *Corticium leptaleum* Ellis & Ev. in C.F. Millspaugh and L.W. Nuttall, Field Columbian Mus. Publ. 9, Bot. Ser. 1:170, 1896.

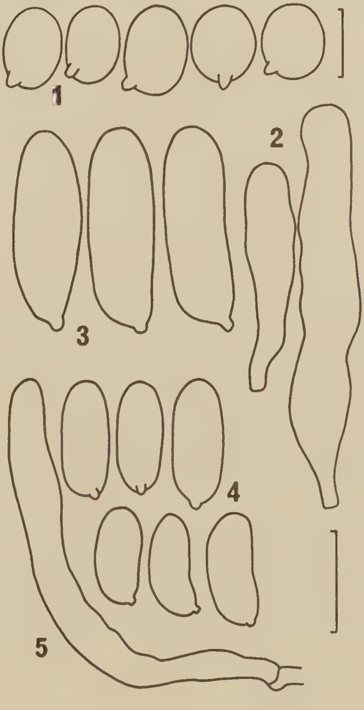
Citation of type: "On under side dead sapling *Magnolia Fraseri*, alt. 1,800 ft. April 11, 1895 (*Nuttall*, discov. 1803, 690)", fide Ellis and Everhart.

Basidiome effuse, about 88 x 30 mm, when fresh it was apparently a membrane which, upon drying, shrunk and cracked, leaving irregular shaped pieces often several millimeters from adjacent pieces; hymenium smooth, translucent, corneus, grayish tan.

Hyphal system monomitic; subicular hyphae 3-6 μm diam, with clamp connections, the walls hyaline, thin, nonamyloid; lamprocystidia imbedded, scattered, with a conical, encrusted apex 40 x 17 μm; basidia slenderly clavate, 40-50 x 7-10 μm with four sterigmata; basidiospores (Fig. 3) cylindrical, 14.6-15.4 x 4.4-4.8 μm, the walls hyaline, thin, smooth, nonamyloid.

Known only from the type collection. The original description appears to cite two collections, but the labelling on the packets indicate that 690 is an Ellis number. Burt (1926: 280) attributed number 690 to Nuttall. I could find no explanation for the meaning of "discov.", although it appears several times in the paper. The two packets I examined are presumed to be isotypes.

The microscopic features are similar to *Hyphoderma mutatum* (Peck) Donk and the combina-



Figs. 1-5. *Corticium epigaeum*. Fig. 1. Basidiospores. Fig. 2. Gloeocystidia. From Carpenter 100 (NY type). *Hyphoderma leptaleum*. Fig. 3. Basidiospores. From Ellis 690 (BPI type). *Hyphoderma rubropallens*. Fig. 4. Basidiospores. Fig. 5. Cystidium. From Bethlehem (PH). Scale in 1 = 5 μm, and applies to 1, 3, and 4. Scale in 5 = 20 μm, and applies to 2 and 5.

tion is proposed to align this fungus with allied species.

Specimens examined: West Virginia: Fayette Co., on bark attached to rotted wood of dead, small *Magnolia fraseri*, 11 April 1895, (254), 1803, J.B.E. 690, "Type material" (BPI 296883), and a second packet with the same data but lacking the number 254 (BPI 282001).

Athelia maculare **(Lair) Ginns, *comb. nov.***

Basionym: *Corticum maculare* Lair, J. Elisa Mitchell Sci. Soc. 62: 216, 1946.

Citation of type: No type specimen was designated and no specimens were cited.

Basidiomes effuse, in pieces 10 x 10 mm and 80 μm thick, crustose, adnate, fissured into irregular polygons 0.5 mm diam; margin white, thin, granulose, to 0.5 mm wide; hymenial surface smooth, pale yellow brown (10YR7/6), glabrous; subiculum very thin, white.

Hyphal system monomitic; subicular hyphae (Fig. 10) short celled (about 20 μm long), much branched, contorted, closely packed, 2.8-4.4 μm, a few heavily encrusted (Fig. 8) and 3-5 μm diam, with clamp connections, the walls hyaline, thin, nonamyloid, acyanophilous; in 51001 there was a layer 10 μm thick of parallel, horizontally arranged hyphae next to the substrate which were heavily encrusted and 4-6 (-9) μm diam; vesicles (Fig. 9) uncommon, globose, 8 μm diam, the walls hyaline, thin, smooth; hymenium and subhymenium with numerous globose granules; immature basidia (Fig. 7) slenderly clavate, 15-22 x 4 μm, with a basal clamp connection; basidia apparently narrowly clavate, 15-20 x 4-4.8 μm, with four sterigmata on each; basidiospores (Fig. 6) cylindrical-ellipsoid, (4.0-) 4.4-4.8 (-5.2) x 2.4-2.6 μm, the walls hyaline, thin, smooth, nonamyloid, with a blunt apiculum.

Mature basidia were rare and were collapsed. This and the numerous granules made it difficult to determine basidial shape and number of sterigmata. Lair described the basidia as "cuboidal", and illustrated them in her figures 11-12, but I did not see any like these.

The hymenium is thicker and the subiculum denser and more adnate than is typical of species of *Athelia*. However, I do not see a better genus for this fungus.

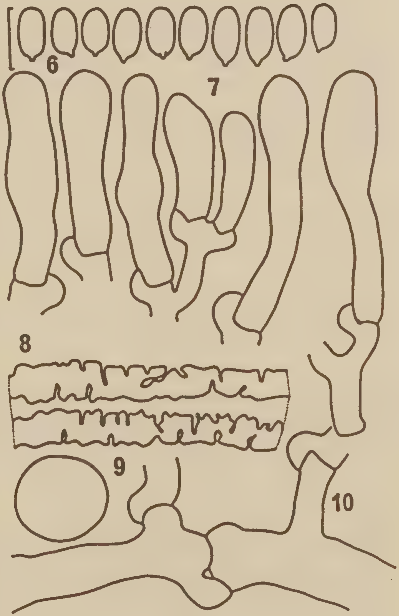
Although reported by Lair to cause Smooth Patch disease of oak, no further reports of the fungus or its disease have been found.

Specimens examined: North Carolina, Durham, 28 Aug. 1945, F.A. Wolf (TRTC), Sept. 1945, FAW (TRTC 51002 herein designated neotype), 25 May 1946, E.D. Lair (TRTC 51001); Chapel Hill, 18 Oct. 1945, J.L. Lowe 2921 (TRTC).

Corticium ochraceum **(Fr.) Fr.**
Epicrisis, p. 563, 1838.

It is perplexing that Burt did not cite the basionym, in this instance *Thelephora ochracea* Fr., Syst. Mycol. 1:446, 1821, because he usually did. Perhaps he thought *C. ochraceum* to be a distinct species from *T. ochracea*. This fungus is now named *Gloeocystidiellum ochraceum* (Fr.) Donk.

Burt (1926:242) cited seven collections from North America, i.e. Alabama, Idaho, Montana, Vermont and Washington. Five were misdetermined. The Alabama and Idaho collections are in poor condition but they are not species of *Gloeocystidiellum*, the Montana collection is a *Phanerochaete*



Figs. 6-10. *Athelia maculare*. Fig. 6. Basidiospores. Fig. 7. Immature basidia. Fig. 8. Segment of encrusted hypha. Fig. 9. Globose vesicle. Fig. 10. Segment of subicular hypha. From TRTC 51002. Scale = 5 µm.

sp., the Vermont collection is a *Hyphoderma* sp., one Washington collection (Humphrey 1454, miscited as 6454) appears to be a species of *Peniophora*. Two Washington collections (Murrill 135 & Humphrey 1373, miscited as 6373) are similar to *G. ochraceum* but with larger and somewhat differently shaped spores than shown by Eriksson and Ryvarden (1975). For the present I accept these (Murrill 135 & Humphrey 1373) as *G. ochraceum*.

Specimens examined: Alabama: Montgomery, Burke 606, MBG 57471 (BPI 282275). Idaho: Priest River, J.R. Weir 59 (FH). Montana: Rexford, E.E. Hubert, JRW 12017, MBG 63373 (BPI 282290). Vermont: Middlebury, on charred *Pinus strobus*, coll. E.A. Burt (BPI 282292). Washington: Seattle, Murrill 135, MBG 55737 (BPI 282274), also 10 Oct. 1909, C.J. Humphrey 1454 (FH); Hoquaim, 22 Oct. 1909, CJH 1373 (FH).

In addition, at BPI there are twelve other collections from the United States labelled *C. ochraceum*, three were determined by Burt. None are, in my opinion, *G. ochraceum*, i.e., BPI 282269 and 282288 are *Resinicium furfuraceum* (Bres.) Parm., BPI 282273 and 282289 are in very poor condition, BPI 282279 is *Coniophora puteana* (Schum.:Fr.) Karst., BPI 282283, 282293, 282296 and 282297 are several species of *Hyphoderma*, BPI 282287 is a *Phanerochaete* sp., BPI 282295 is a *Grandinia* sp., and BPI 282297 is a *Phlebia* sp.

Corticium ravum Burt
Ann. Missouri Bot. Gard. 13: 251, 1926.

Citation of type: "Louisiana: St. Martinville, *A.B. Langlois, 1765* and *N*, type", fide Burt.

Burt cited collections from Brazil and Cuba, and five collections from the Gulf Coast-Lower Mississippi River area of the United States, i.e., Alabama, Florida, Louisiana, and Missouri.

The holotype (Langlois N) is a specimen of *Gloeocystidiellum karstenii* and the name *C. ravum* is placed in synonymy. The paratype from Alabama and a South Carolina collection labelled *C. ravum*, but not cited by Burt, are also *G. karstenii*. Some spores in the three collections were up to 1 μm longer and 0.5 μm wider than the sizes given for collections from Europe (Eriksson and Ryvarden

1975). The gloeocystidia in the holotype were sulfo-negative but in the other two collections some gloeocystidia stained grey black.

The remaining collections, all paratypes, cited by Burt are not conspecific. The Florida collection is similar to *G. karstenii* but has larger spores (8-) 10 (-12) x 4.5-5.0 (-6.0) μm, slightly larger verrucae on the spores, slightly broader hyphae 3-5 μm diam and broader basidia 10 μm diam. The part at BPI was probably not seen by Burt. The second collection from Louisiana (Langlois 1765) Burt cited is *G. clavuligerum.* The Missouri collection is sterile but is not *G. karstenii* because it lacks sulfo-positive gloeocystidia and the hyphae have clamp connections. Finally, the Cuban collection is a *Gloeocystidiellum* with small, smooth spores, 5.2-5.6 x 4.0-4.4 μm, which are significantly smaller than the spores in the holotype.

Specimens examined: Cuba: Omaja, 20 Dec. 1914, on lower half of prostrate hardwood log, C.J. Humphrey 3056 (FH). USA: Alabama: Montgomery, on bark of hardwood twigs 15 mm diam, R.P. Burke 126, MBG 5282 (BPI 282695). Florida, Feb. 1899, on bark of hardwood twigs about 10 mm diam, C.G. Lloyd 4832 (BPI 330512 = Lloyd Herb. 46057, FH). Louisiana: near St. Martinville, 23 Nov. 1899, on bark of 20 mm diam hardwood branches, A.B. Langlois N (FH holotype) and 22 Aug. 1898, on bark of a hardwood, ABL 1765 (FH). Missouri: Creve Coeur, Oct. 1913, coll. E.A. Burt, MBG 44045 (BPI 282693). South Carolina: St. Stephens, 26 Oct. 1923, on bark of branch of *Nyssa* sp. 20 mm diam, C.L. Shear, FP 71137, det. H.S. Jackson (BPI 282696, DAOM 31352).

Corticium rubrocanum **Thümen**

Mycotheca Univ. Exs. 409, 1876 and Torrey Bot. Club. Bull. 6: 95, June 1876.

Citation of type: "Newfield, N.J. ad *Quercus coccineae* ramos emortuos. Vere 1875. Leg. T. (sic) B. Ellis. (no. 2248)", fide Thümen.

The type collection was distributed in Thümen's exsiccatae as number 409. I have studied four copies of 409 but no spores were seen. The most distinctive features of this fungus are the botryose dendrophyses (Fig. 11), hyaline hyphae with clamp connections, clavate hymenial elements with brown walls, and the occasional globose vesicle. The dendrophyses dissolve in 2% KOH, do not stain in Melzer's, are common in the hymenial area, have the terminal branches 0.5 μm diam, and the stem is 1.6 μm diam.

Burt (1926:231) cited, in addition to the type, five specimens. He did not find spores. These collections and several others also labelled *C. rubrocanum*, were studied by me. All the collections, except 5111, are conspecific with the type but no basidiospores were seen. Collection 5111 from Louisiana lacks dendrophyses, apparently has sulfo-negative gloeocystidia and has smooth, amyloid spores about 6 x 3 μm.

Although *Corticium rubrocanum* is known from several collections, in the absence of basidiospores it is not possible to concisely characterize this fungus. However, the available features of *C. rubrocanum* are the same as those of the type specimen of *C. albido-carneum* (see above), and the name *C. rubrocanum* is placed in synonymy.

Specimens examined: Alabama: Montgomery, on bark of *Quercus* branch 15 mm diam, R.P. Burke 105, MBG 11280 (BPI 282822). Louisiana: St Martinville, on bark of dead twigs of *Quercus* 10 mm diam, 11 April 1898, A.B. Langlois 1993 (FH); no location, on bark of *Quercus* branch 20 mm diam, 28 Nov. 1899, B. Labbe, Herb. Langlois (BPI 282817); Natchitoches, Feb. 1899, G.D. Harris, Cornell U. 5111 (FH). New Jersey: Newfield, on dead branches to 10 mm diam of *Quercus*, coll. Ellis, s.d., Herb. Eugene A. Rau (BPI 282807); on bark of underside of dead limbs of *Q. coccinea*, "Ver. E.A.B." script. E.A. Burt, North American Fungi 22 (BPI 282819); 24 April 1876, ex Herb. Ellis, MBG 44638 (BPI 282814); on *Quercus* limbs, April 1888, J.B. Ellis, MBG 4846 (BPI 282811); on twigs to 10 mm diam of *Q. coccinea*, Vere 1875, JBE 2248, Mycotheca Univ. 409 (BPI 282818, DAOM and two packets in the BPI exsiccatae collection, all isotypes). South Carolina, on bark of rotten limb of *Quercus*, Feb., H.W. Ravenel 377 (FH).

Hyphoderma rubropallens* (Schw.) Ginns, *comb. nov.

Basionym: *Thelephora rubropallens* Schw., Amer. Philos. Soc. Trans., n.s. 4: 168, 1832.

Synonym: *Corticium rubropallens* (Schw.) Massee, J. Linn. Soc., Bot. 27: 145, 1890.

Citation of type: "longe lateque effusa in corticibus et lignis Bethlehem", fide Schweinitz.

Basidiome effuse, only small patches about 5 x 5 mm remain, up to 200 μm thick, adnate, at 10x pale violet grey (near 10YR8/4) to pale greyish brown (10YR7/4), somewhat ceraceous but softening immediately when wetted; hymenial surface smooth; margin no longer extant.

Hyphal system monomitic; generative hyphae distinct, randomly woven, except next to the substrate where they are horizontally arranged in a layer about 20 μm thick, not encrusted, short-celled, frequently branched, with clamp connections, 3-4.6 μm diam with some inflations to 7 μm, the walls hyaline, thin, nonamyloid; cystidia (Fig. 5) uncommon, originating in the subiculum, apparently terminating in the hymenium but the apices poorly preserved, cylindrical, 70-100 x 8-10 μm, the walls hyaline, thin, smooth, nonamyloid, the contents sulfo-negative, in Melzer's with granular or oily patches (all other cells have homogeneous contents); mature basidia not seen with certainty, immature basidia somewhat shrunken, clavate, 17 x 6 μm; basidiospores (Fig. 4) rather common on top of the hymenium, cylindrical-ellipsoid, adaxially flattened to slightly concave, (8.0-) 8.4-9.4 (-9.6) x 3.2-4.0 μm, the walls hyaline, thin, smooth, nonamyloid, with a broad, blunt apiculus.

This description was taken from the collection in the Schweintiz Herbarium (PH). It has been about 90% devoured by insects. This packet contains two pieces, one wrapped in rather heavy paper and the other glued to blue-lined paper. The description was taken from the part on the blue-lined paper. A presumed piece of the type in the Michener Collection could not be adequately characterized because it had been devoured by insects.

Burt (1926:230) cited only two collections, the type in the Schweinitz Herbarium and a collection from Alabama. Burt's description is a composite. The Alabama collection is a species of *Scytinostroma* but no spores were found.

The Schweinitz collection has shorter and narrower spores, and a somewhat denser, more adnate basidiome but in other respects is very similar to *Hyphoderma roseocremeum* (Bres.) Donk, according to specimens from Alberta (DAOM 142404) and Sweden (DAOM 68628), hence the transfer to *Hyphoderma* is proposed.

Specimens examined: Alabama: Montgomery, June 1910, on board of hardwood, R.P. Burke 118, MBG 19557 (BPI 282823). Pennsylvania: Bethlehem (PH herein designated neotype), ex Herb. Schweinitz, Michener Collection 13:18 (BPI).

Ceraceomyces subapiculatus **(Bres.) Ginns, *comb. nov.***
Basionym: *Corticium subapiculatum* Bres., Mycologia 17: 69, 1925.

Citation of type: "ad truncos *Pini*, Idaho. (*Weir 16928.*)", fide Bresadola.

Basidiomes effuse, in pieces, the largest being 100 x 30 mm and 300 µm thick, athelioid; hymenial surface smooth, delicate, crustose, pastel yellow to cream color; margin not extant; subiculum very thin, white to pallid.

Hyphal system monomitic; subicular hyphae loosely woven, with clamp connections, 3.2-7.5 µm diam, the walls hyaline, thin to 0.8 µm thick, nonamyloid, acyanophilous; all cells in the hymenium have a basal clamp connection; cystidia (Fig. 13) scattered in the marginal area, cylindrical, with a broadly rounded apex, septate with a clamp connection at each septum, 3.6 µm diam, projecting to 16 µm; basidia (Fig. 14) cylindrical-clavate, 28-30 x 5-7 µm, with four sterigmata, when mature projecting 10-15 µm; basidiospores (Fig. 12) cylindrical-ellipsoid, (6.0-) 6.2-8.0 (-10.0) x 3.0-3.6 µm, the walls hyaline, thin, smooth, nonamyloid, acyanophilous, with a rather broad blunt apiculus. Spore print pallid to white when dry and on black paper.

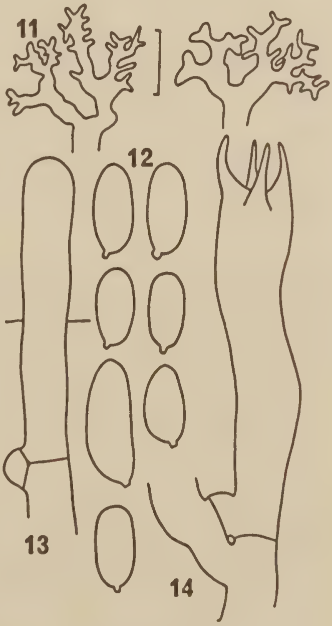
Burt (1925:280) transferred the epithet to *Peniophora* and cited eight collections from British Columbia, Idaho and Montana. Five, including the type, have been studied by me. One (BPI 283100) of the Montana collections is identical with the type, but the other (BPI 289035) is a specimen of *Grandinia alutaria* (Burt) Jülich. Two Idaho collections (BPI 289034 & 289037) are specimens of *Fibricium rude* (Karst.) Jülich.

My observations agree with the comments by Rogers and Jackson (1943) who studied the type and all other specimens, with one exception, cited by Burt. They stated "All of the six (sic) additional collections assigned to this species by Burt have been examined. Three of them prove to be *Peniophora greschikii* (Bres.) Bourd. & Galz. ..., and two are *Peniophora pallidula* Bres., neither of which resembles *C. subapiculatum* at all closely. Only one (Weir 414) from Evaro, Montana, is like the type."

Although Burt described cystidia as "hair-like, not encrusted, cylindric, obtuse, 3-4½ μ in diameter, protruding 10-40 μ beyond the basidia", Rogers and Jackson stated, "An examination of the type fails to reveal any cystidia." Perhaps Rogers and Jackson were expecting to find differentiated cystidia, for I found structures that fit Burt's description of cystidia.

The type is similar to *Ceraceomyces tessulatus* (Cooke) Jülich, hence the transfer to *Ceraceomyces* is proposed.

Specimens examined: Idaho: Clarkia, 23 Jan. 1920, on underside of charred, decorticated log of *Pinus monticola*, A.S. Rhodes, J.R. Weir 16928 (BPI 289032); Coolin, 18 Sept. 1919, on *Thuja plicata*, JRW 11086, MBG 63245 (BPI 289037); Priest River, 30 July 1919, on conifer bark, twigs and needles, E.E. Hubert, JRW 12020, MBG 63375 (BPI 289034). Montana: Evaro, 17 Sept. 1915, on decorticated wood of *Pinus ponderosa*, JRW 414, MBG 63720 (BPI 283100); Kalispell, 20 Sept. 1919, on bark of *P. monticola*, E.E.



Figs. 11-14. *Corticium rubrocanum*. Fig. 11. Dendrophyses. From Thümen, 409 (BPI Exsiccatae Collection). *Ceraceomyces subapiculatus*. Fig. 12. Basidiospores. Fig. 13. Cystidium. Fig. 14. Basidium. From Weir 16928. Scale in 11 = 5 μm, and applies to 11-14.

Hubert, JRW 11957 (BPI 289035).

Corticium subcontinuum Berk. & Curt.
J. Linn. Soc., Bot. 10: 337, 1868.

Citation of type: Cuba, Charles Wright 537, on bark, fide Berkeley and Curtis.

Burt (1926:288) cited four collections from the United States, three from Louisiana and one from Texas. All have been studied by me. The Texas collection is a *Phanerochaete* sp. One Louisiana collection (BPI 283118) is a *Hypochniciellum* sp.; the second (BPI 283116), although sterile, represents another species; and the third (Langlois 1761a at FH) is indeterminable.

A collection from British Columbia determined by Burt as *C. subcontinuum*, but not cited, is an athelioid fungus, which I did not attempted to identify further.

The type (at K) lacks basidia and spores, but may be a species of *Duportella*, fide Hjortstam (1989). Although Burt (1926) stated that part of the type was at FH it was not found in 1990.

The occurrence of this fungus in Canada and the United States could not be substantiated, thus it is not accepted as part of the mycoflora.

Specimens examined: Canada: British Columbia: Salmo, on bark of *Larix occidentalis*, Sept. 1915, J.R. Weir 1832, det. Burt 511 (BPI 283119). USA: Louisiana: Ruston, beneath rotten prostrate sapling of *Pinus echinata*, 16 July 1914, C.J. Humphrey 2532, MBG 12495 (BPI 283118); St. Martinville, A.B. Langlois 1761a (FH) and 1761b, MBG 42598 (BPI 283116). Texas, Ch. Wright, as *Corticium calceum* Fr. (BPI 283114).

Corticium subochraceum Bres.
Hedwigia 35: 290, 1896.

Citation of type: "ad cortices arborum >Blumenau< Braziliae (n. 274)", fide Breasdola.

Basidiome fragmented, the piece studied 20 x 15 mm and about 70 μm thick, adnate; margin white to concolorous, at 10x finely granulose, to 0.5 mm wide; hymenial surface smooth, dull, crustose, yellow brown (near 7.5YR6/6); subiculum very thin, white.

Hyphal system monomitic; subicular hyphae closely packed, woven, frequently branched and septate, with clamp connections, 4-5 (-6) μm diam, the walls thin to 0.5 μm thick, nonamyloid, acyanophilous; subhymenial hyphae mostly encrusted with 1 μm diam, pale yellow, acyanophilous granules; lamprocystidia imbedded, scattered, the encrusted apex conical, 28 x 12 μm; basidia in a tight palisade and detail obscure; basidiospores (Fig. 19) numerous, cylindrical-ellipsoid, 4.8-5.6 x (2.4-) 2.8 μm, the walls hyaline, thin, smooth, nonamyloid, acyanophilous, with a small, blunt apiculum.

The above description was taken from the Brasilian isotype. The six collections from the United States cited by Burt (1926:290) represent five or six species, and none is conspecific with the isotype. The fungus is not part of the mycoflora of the United States.

Specimens examined: Brazil, 1892, Dr. Möller, ex Herb. Bresadola (FH-Burt Herb. isotype). USA: Alabama: Montgomery Co., Sept. 1917, Herb. Burke 338, BG 57212 (BPI 283168), Auburn, 1897, on *Melia*, F.S. Earle & C.F. Baker, MBG 58325 (BPI 283173). Louisiana: St. Martin[ville], A.B. Langlois 1345, MBG 42603 (BPI 283174), 7 May 1899, ABL "ab" (FH), 19 May 1899, ABL "W" (FH). Nebraska: Lincoln, May 1895, C.L. Shear 1341 (BPI 283170).

Clavulicium venosum (Berk. & Rav.) Ginns, _comb. nov._

Basionym: *Corticium venosum* Berk. & Rav., Grevillea 1: 177, 1873.

Citation of type: "Rav. No. 1321", fide Berkeley and Ravenel.

Basidiome effuse, in pieces about 30 x 30 mm and 400 μm thick, horny, membranous; margin pallid (near 2.5Y8/4), fimbriate to reticulose, adnate, thin, up to 1 mm wide; hymenial surface smooth but with faint branched ridges which suggests it was rugose when fresh, pallid (near 2.5Y8/4) to blackish grey (near 2.5Y6/2); subiculum concolorous with hymenium, horny.

Hyphal system monomitic; subicular hyphae (Fig. 18) in some sections apparently in a gelatinized matrix, branched, 2-3 µm diam, with frequent clamp connections, the walls thin, hyaline, nonamyloid, acyanophilous; gloeocystidia (Fig. 16) scattered, originating in the subiculum next to the subhymenium, cylindrical, curved into the hymenium, imbedded or rarely projecting to 15 µm, 70-100 x 4-7 µm, the contents granular, refractive, and yellow-brown in Melzer's and 2% KOH, dark blue in cotton blue, sulfo-negative; hymenium and subhymenium about 70 µm thick; basidia (Fig. 17) cylindrical, about 35 x 5-7 µm, with two sterigmata, each about 8µm long; basidiospores (Fig. 15) cylindrical-ellipsoid, 11.2-16.0 x 5.0-6.0 (-7.0) µm, the contents finely granular and subhyaline in KOH, the walls hyaline, thin, nonamyloid, cyanophilous, with a prominent, broad, blunt apiculum.

The only specimen known of this fungus is the type. Burt (1926) mentioned that the specimen at Kew had "*Auricularia*" written on the label, but he was not able to confirm that the fungus had auricularioid basidia. Hjortstam (1989) after examining the part at Kew stated "an auriculariaceous species", but gave no supporting facts. I found, with difficulty, only a few two-spored holobasidia and no auricularioid basidia.

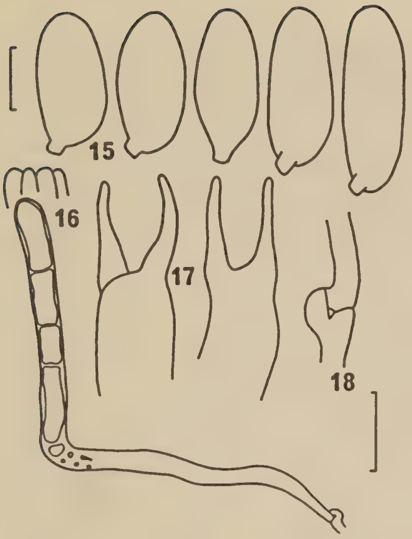
In addition to the two sterigmate basidia this fungus has other features similar to those of *Clavulicium macounii* (Burt) Parm. Both have gloeocystidia which are similar in size, shape and contents, both have narrow hyphae, both have relatively large spores with granular or oily contents, and both have pale yellow, globular deposits, 15-20 µm diam in the basidiomes. The two are congeneric, hence the transfer to *Clavulicium* is proposed.

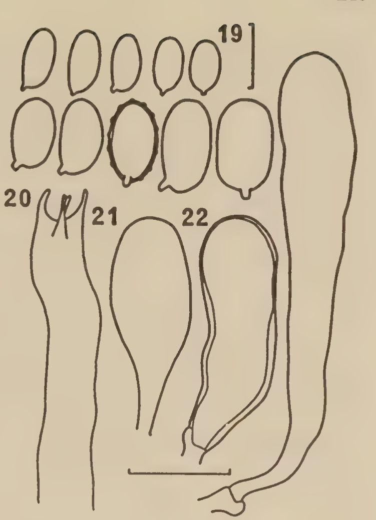
Specimen examined: South Carolina: Black Oak, Sept., on carious logs (very rotten), Ravenel 1321 (FH, Curtis Herb.).

Hypochnicium versatum* (Burt) Ginns, *comb. nov.

Basionym: *Peniophora versata* Burt, Ann. Missouri Bot. Gard. 12: 305, 1925.

Synonym: *Corticium versatum* (Burt) Rogers & Jackson, Farlowia 1: 326, 1943.





Figs. 15-18. *Clavulicium venosum*. Fig. 15. Basidiospores. Fig. 16. Imbedded gloeocystidium. Fig. 17. Two sterigmate holobasidia. Fig. 18. Segment of subicular hypha. From Ravenel 1321. Scale in 15 = 5μm, and applies to 15, 17 and 18. Scale in 16 = 20 μm.

Figs. 19-22. *Corticium subochraceum*. Fig. 19. Basidiospores. From Brazil, 1892. *Hypochnicium versata*. Fig. 20. Basidiospores, one drawn in median view to show wall thickness and ornamentation. Fig. 21. Apical portion of basidium. Fig. 22. Gloeocystidia. From Humphrey 7623. Scale in 19 = 5 μm, and applies to 19, 20 and 21. Scale in 22 = 20 μm.

Citation of type: Washington: "Edmonds, *C.J. Humphrey, 7623,* type", fide Burt.

Basidiomes effuse, up to 50 x 15 mm and up to 250 μm thick; margin indistinct, determinate, about 0.5 mm wide; hymenial surface smooth, dull, pale yellow (near 2.5Y8/4); subiculum thin, white, fibrous when wetted.

Hyphal system monomitic; subicular hyphae closely packed, woven, 2.5-3.0 (-5.0) μm diam, with clamp connections, the walls thickened, gelatinized, hyaline, nonamyloid, acyanophilous; subhymenium occupying most of the thickness of the basidiome, with hyphae vertically oriented and similar to subicular hyphae; gloeocystidia (Fig. 22) numerous, imbedded or some projecting to 10 μm, clavate to broadly clavate, 35-100 x 8-15 μm, the contents granular, pale yellow in KOH, sulfo-positive, the walls hyaline, smooth, thin or, in a few, thickened to 1.5 μm; lamprocystidia lacking; basidia (Fig. 21) slenderly clavate, about 40 x 6.0-6.5 μm, with four sterigma each 4 μm long; basidiospores (Fig. 20) broadly ellipsoid, (6.5-) 6.8-8.2 (-8.4) x 4.0-4.8 μm, the walls hyaline, most thickened to 0.4 μm, most finely roughened with warts to 0.2 μm diam, nonamyloid, acyanophilous, with a blunt apiculum.

The above description was taken from the holotype. The sulfo-positive gloeocystidia, the finely warted, slightly thick-walled basidiospores, and the thick-walled, gelatinized, narrow hyphae are the principal features of this fungus. These features exclude it from the genera *Corticium* and *Peniophora*, where it has been previously placed. *Hypochnicium analogum* (Bourd. & Galzin) Eriksson with its thick-walled, ornamented basidiospores and sulfo-positive gloeocystidia is similar, hence the transfer to *Hypochnicium* is proposed.

Burt (1925: 305) cited two collections, the holotype (7623) and Humphrey 6285. They are specimens of the same species. Both are on conifer lumber that shows little sign of decay. The report (Conners 1967) from British Columbia was based on F9820 which is *Gloeocystidiellum ochraceum*.

Specimens examined: USA: Washington: Edmonds, 25 Sept. 1910, underside of old (conifer) plank, C.J. Humphrey 7623 (FH Burt Herb.); Chehalis, 15 Oct. 1909, underside of slightly decayed red fir tie, CJH 6285 (FH Burt Herb.). Canada: British Columbia: Saanichton, 26 Nov. 1939, on bark of dead sapling of *Pseudotsuga menziesii*, J.E. Bier (DAOM F9820).

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The study of specimens discussed in this paper was essentially completed during a visit to the National Fungus Collections (BPI) in March 1990. Drs. Amy Rossman and David Farr, and the staff provided valuable assistance that made the visit profitable and enjoyable. Dr. D.H. Pfister (FH) kindly loaned specimens from the Burt Herbarium and the Curtis Collection. Ms. Louise Lefebvre completed the layout and inking of the plates.

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A LIST OF SPECIES NAMES ASSIGNED TO THE GENUS *CATACAUMA*

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ABSTRACT

Because of the lack of keys, identification of nongraminicolous species of *Phyllachora* from the tropics can be accomplished only by searching out descriptions in the literature. Although *Catacauma* has long been regarded as a synonym of *Phyllachora*, a number of *Catacauma* species have not been transferred to *Phyllachora*, where they presumably belong. Consequently, species described under *Catacauma* also must be considered when identifying *Phyllachora* species. A search of the literature revealed 112 species assigned to *Catacauma*, 42 of which were originally described in that genus. A complete list of species names in *Catacauma* has been compiled, including data on the basionym of species transferred to the genus. The host, and locality where found, are also listed.

Keywords: Ascomycotina, *Catacauma, Phyllachora*, tar spot, tropical ascomycetes.

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INTRODUCTION

The genus *Catacauma* was erected by Theissen and Sydow (1914, 1915) to accommodate species of *Phyllachora* Nitschke ex Fuckel in which the perithecia form between the host epidermis and the subepidermal tissues. *Phyllachora* was restricted to those species in which the perithecia were immersed in the interior tissues of the leaf. A few years later, Petrak (1927) pointed out that the location of the perithecium in phyllachoroid fungi was a variable characteristic and that it was not a suitable taxonomic criterion at the generic level. He reduced *Catacauma* to synonymy with *Phyllachora*, a move supported by most subsequent taxonomists. Despite Petrak's opinion, however, *Catacauma* continued to be used for some time by several collectors of tropical fungi.

During the past few years numerous *Phyllachora* species on nongraminicolous hosts have been collected in Brazil and Venezuela. In attempting to identify these fungi, it has been necessary to compile descriptions of tropical *Phyllachorae* from the literature. It was discovered while doing this that a number of species originally described in *Catacauma* have never been transferred to *Phyllachora*. While it would be premature to do this without first examining type specimens to be certain the species belong in *Phyllachora*, the names nevertheless must be considered when attempting to identify *Phyllachora* species. Consequently, a list of species names described in or transferred to *Catacauma* has been compiled from the literature. Of the 112 species names assigned to the genus, 42 were originally described as *Catacauma*. No species of *Catacauma* has been described on a graminicolous host, and only a few were described from monocotyledons. Most species occur on hosts with leaves that are thick and leathery, and Petrak (1927) believed that this was responsible for the formation of the perithecia between the epidermis and subepidermal tissues. In hosts with softer textured tissues, the perithecia can form readily within the leaf tissues.

This list is presented here to assist others who may have a need to identify tropical *Phyllachora* species. It contains all names assigned to *Catacauma*, the literature reference, and the host and locality cited in that reference. Since not all of the data have been checked for accuracy against the original publications, it must be regarded as a preliminary listing of species.

CATACAUMA Theiss. et H. Syd. - Ann. Mycol. 12:280. 1914.
(*Catacauma* = Brandblase)

Stroma zwischen Epidermis und Palissaden, von der stromatisierten Epidermis bedeckt, aus senkrechten Hyphen gebildt. Loculi eingesenkt. Asken paraphysiert. Sporen farblos, einzellig.
Typus: *C. exanthematica* (Lév.) Theiss. et H. Syd.
Basionym: *Dothidea exanthematica* Lév.

CATACAUMA Theiss. et H. Syd. - Ann. Mycol. 13:371. 1915.
Stroma applanatum, inter epidermidem et stratum subepidermalem, clypeo epidermali tectum, verticaliter prosenchymatice constructum (typice); loculi immersi; asci paraphysati octospori; sporidia hyalina simplicia.

acaciae Theiss. et H. Syd. - Ann. Mycol. 13:389. 1915.
On *Acacia leucophloea*, Madras, India.

acaenae (Henn.) Theiss. et. H. Syd. - Ann. Mycol. 13:387. 1915.
Basionym: *Phyllachora acaenae* Henn.
On *Acaena ovalifolia*, Concepción, Chile.

aloeticum (Berk. et M. A. Curtis) Theiss. et H. Syd. - Ann. Mycol. 13:399. 1915.
Basionym: *Dothidea aloetica* Berk. et M. A. Curtis
On leaves of unindentified plant, Cuba.

alpiniae (Sacc. et Berl.) Theiss. et H. Syd. - Ann. Mycol. 13:375. 1915.
Basionym: *Phyllachora alpiniae* Sacc. et Berl.
On *Alpinia coerulea*, Brisbane, Australia.

amyridis (Seaver) Chardon. - J. Dept. Agric. Puerto Rico 16(2):170. 1932.
Basionym: *Phyllachora amyridis* Seaver
On *Amyris elemifera*, Hispaniola and Puerto Rico.

apoense (H. Syd. et P. Syd.) H. Syd. - Ann. Mycol. 13:379. 1915.
Basionym: *Phyllachora apoensis* H. Syd. et P. Syd.
On *Ficus sibulanensis* and *F. apoensis*, Mindanao, Philippines.

aspideum (Berk.) Theiss. et H. Syd. - Ann. Mycol. 13:380. 1915.
Basionym: *Dothidea aspidea* Berk.
On *Ficus repens*, Sri Lanka (Ceylon).

aspideum (Berk.) Theiss. et H. Syd. forma ***fici-albae*** (Koord.) Theiss. et H. Syd. - Ann. Mycol. 13:381. 1915.
Basionym: *Phyllachora fici-albae* Koord.
On *Ficus alba*, Java.

aspideum (Berk.) Theiss. et H. Syd. forma ***fici-fulvae*** (Koord.) Theiss. et H. Syd. - Ann. Mycol. 13:381. 1915.
Basionym: *Phyllachora fici-fulvae* Koord.
On *Ficus* sp., Luzon, Philippines.

aspideum (Berk.) Theiss. et H. Syd. forma ***spinifera*** (Karst. et Har.) Theiss. et H. Syd. - Ann. Mycol. 13:380. 1915.
Basionym: *Phyllachora ficuum* Niessl var. *spinifera* Karst. et Har.
On *Ficus rideli*, Africa, and on *Ficus odorata*, Luzon, Philippines.

aspideum (Berk.) Theiss. et H. Syd. forma ***urostigamatis-tomentosi*** Theiss. et H. Syd. - Ann. Mycol. 13:380. 1915.
On *Ficus sp.*, Sri Lanka.

biguttulatum (Theiss.) Theiss. - Ann. Mycol. 13:396. 1915.
Basionym: *Phyllachora biguttulata* Theiss.
On *Campomanesia rhombea*, Rio Grande do Sul, Brazil.

brittoniana Chardon - Mycologia 19:298. 1927.

On *Ficus subscabrida*, Isle of Pines, Cuba.

cabalii Garces - Caldasia 1941:79. 1941.
On *Pouteria cainito*, Colombia.

caracaense (Rehm) Theiss. et H. Syd. - Ann. Mycol. 13:389. 1915.
Basionym: *Phyllachora pestis-nigra* Speg. var. *caracaensis* Rehm
On Malpighiaceae, Caraca, Minas Gerais, Brazil.

caseariae (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:393. 1915.
Basionym: *Phyllachora caseariae* Henn.
On *Casearia* sp., Manaos, *Casearia silvestris* and *C. inaequilateralis*, Rio Grande do Sul, Brazil.

centrolobiicola (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:389. 1915.
Basionym: *Phyllachora centrolobiicola* Henn.
On *Centrolobium* sp., Tarapoto, Peru.

circinata (H. Syd. et P. Syd.) H. Syd. - Ann. Mycol. 13:377. 1915.
Basionym: *Phyllachora circinata* H. Syd. et P. Syd.
On *Ficus* sp., Luzon, Philippines.

contractum H. Syd. - Ann. Mycol. 23:365. 1925.
On *Gouania tomentosa*, La Caja, Costa Rica.

copaiferiicola Chardon - Mycologia 32:185. 1940.
On *Copaifera* sp., Brazil.

costaricense Chardon - J. Dept. Agric. Porto Rico. 13(1):8. 1929.
On *Xylosma velutina* and *X. oligendri*, Costa Rica, and on *Xylosma* sp., Honduras.

costaricensis Stevens - Illinois Biol. Monogr. 11(2):184. 1927.
On *Myrcia costaricensis*, Costa Rica.

cubense Theiss. et H. Syd. - Ann. Mycol. 13:391. 1915.
On Sapindaceae, Cuba.

dalbergiicola (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:388. 1915.
Basionym: *Phyllachora dalbergiicola* Henn.
On *Dalbergia variabilis*, Matto Grosso, Brazil.

dalbergiicola (Henn.) Theiss. et H. Syd. var. ***philippinensis*** Theiss. et H. Syd. - Ann. Mycol. 14(1- 2):447. 1916.
On *Dalbergia ferruginea*, Philippines.

dalbergiicola (Henn.) Theiss. et H. Syd. var. ***philippinensis*** Theiss. et H. Syd. forma ***conidiifera*** H. Syd. - Fungi Exotici Exsiccati Fasc. X-XI (Nos. 451-550): No. 518. 1923.
On *Dalbergia ferruginea*, Philippines.

davillae Viégas - Bragantia 7:108. 1947.
On *Davilla rugosa*, Brazil.

decaisneanum (Lév.) Theiss. et H. Syd. - Ann. Mycol. 13:384. 1915.
Basionym: *Dothidea decaisneana* Lév.
On *Ficus lacta*, Timor, Indonesia.

distinguendum (Rehm) Theiss. et H. Syd. - Ann. Mycol. 13:397. 1915.
Basionym: *Phyllachora distinguenda* Rehm

On Myrtaceae, Minas Gerais, Brazil.

dothidea (Moug.:Fr.) Höhn. - Ann. Mycol. 20:4. 1922.
Basionym: *Sphaeria dothidea* Moug.:Fr.
On *Rosa* sp., Sarajevo, Yugoslavia.

dussiae H. Syd. et P. Syd. - Ann. Mycol. 18:159. 1920.
On *Dussia martinicensis*, Guadaloupe.

egenulum H. Syd. - Leafl. Philipp. Bot. 9:3129. 1925.
On *Eugenia everettii*, Philippines.

egregium (Rehm) Theiss. et H. Syd. - Ann. Mycol. 13:391. 1915.
Basionym: *Phyllachora phyllanthophila* Henn. var. *egregia* Rehm
On *Phyllanthus* sp., São Paulo and Rio Grande do Sul, Brazil.

elaeocarpi T.S. Ramakrishnan et K. Ramakrishnan - Proc. Indian Acad. Sci., Sect. B, 28:57. 1948.
On *Elaeocarpus munroi*, India.

elettariae T.S. Ramakrishnan et K. Ramakrishnan - Proc. Indian Acad. Sci., Sec. B, 32:99. 1950.
On *Elettaria cardamomum*, Madras, India.

elmeri (H. Syd. et P. Syd.) H. Syd. - Ann. Mycol. 13:378. 1915.
Basionym: *Phyllachora elmeri* H. Syd. et P. Syd.
On *Ficus manilensis*, Mindanao, Philippines.

eugeniicola Chardon - Mycol. Explor. Venezuela, Monogr. Univ. Puerto Rico, Ser. B, 2:143. 1934.
On *Eugenia* sp., Venezuela.

euryae (Racib.) Theiss. et H. Syd. - Ann. Mycol. 13:392. 1915.
Basionym: *Myocopron euryae* Racib.
On *Eurya acuminata*, Java.

exanthematica (Lév.) Theiss. et H. Syd. - Ann. Mycol. 13:371. 1915.
Basionym: *Dothidea exanthematica* Lév.
On leaves of unidentified plant, Marquesas.

feijoae (Rehm) Theiss. et H. Syd. - Ann. Mycol. 13:397. 1915.
Basionym: *Phyllachora feijoae* Rehm
On *Feijoa* sp., Minas Gerais, Brazil.

fici-obscurae (Koord.) Theiss. et H. Syd. - Ann. Mycol. 13:378. 1915.
Basionym: *Phyllachora fici-obscurae* Koord.
On *Ficus obscura*, Java.

flabellum (Schwein.) Theiss. et H. Syd. - Ann. Mycol. 13:372. 1915.
Basionym: *Sphaeria flabella* Schwein.
On *Pteris aquilina*, North America.

flavo-cinctum (Rehm) Theiss. et H. Syd. - Ann. Mycol. 13:399. 1915
Basionym: *Phyllachora flavo-cincta* Rehm
On leaves of unidentified tree, Tubarao, Santa Catharina, Brazil.

forsteroniae (Rehm) Theiss. et H. Syd. - Ann. Mycol. 13:398. 1915.
Basionym: *Physalospora forsteroniae* Rehm
On *Forsteronia pubescens*, Rio de Janeiro, Brazil.

fructigenum (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:386. 1915.
Basionym: *Phyllachora fructigena* Henn.
On *Nectandra* sp., Goyas, Brazil.
galactiae Stevens - Ann. Mycol. 29:102. 1931.
On *Galactia speciosa*, Peru.
garciae Theiss. et H. Syd. - Ann. Mycol. 13:381. 1915.
On *Ficus garciae*, Puerto Princesa, Palawan, Philippines.
glaziovii (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:374. 1915.
Basionym: *Phyllachora glaziovii* Henn.
On *Dioscorea pachycarpa*, Rio de Janeiro, Brazil.
gouaniae (Stevens) Viégas - Bol. Soc. Bras. Agron. 7(4):374. 1944.
Basionym: *Catacaumella gouaniae* Stevens
On *Gouania virgata*, Brazil.
goyazense (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:396. 1915.
Basionym: *Phyllachora goyazensis* Henn.
On Myrtaceae, Minas Gerais, Brazil.
gracillimum (Speg.) Theiss. et H. Syd. - Ann. Mycol. 13:373. 1915.
Basionym: *Phyllachora gracillima* Speg.
On *Isolepis capillaris*, Brazil.
grammicum (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:382. 1915.
Basionym: *Phyllachora grammica* Henn.
On *Ficus sp.*, Kisantu, Congo.
hammari (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:389. 1915.
Basionym: *Phyllachora hammari* Henn.
On *Machaerium* sp., São Paulo, Brazil.
himalayanum Padwick - Mycol. Pap., Imp. Mycol. Inst. 12:4. 1945.
On *Ficus faveolatus*, India.
huberi (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:390. 1915.
Basionym: *Phyllachora huberi* Henn.
On *Hevea brasiliensis, H. nivea, and H. pauciflora*, Brazil.
infectorium (Cooke) Theiss. et H. Syd. - Ann. Mycol. 13:384. 1915.
Basionym: *Phyllachora infectoria* Cooke
On *Ficus infectoria*, India.
ingae Chardon - J. Dept. Agric. Porto Rico 13(1):9. 1929.
On *Inga vera*, Puerto Rico.
irregulare (Welw. et Curr.) Theiss. et H. Syd. - Ann. Mycol. 13:377. 1915.
Basionym: *Isothea irregularis* Welw. et Curr.
On *Ficus* sp., Angola.
kambachii (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:376. 1915.
Basionym: *Phyllachora kambachii* Henn.
On *Ficus* sp., New Guinea.
lagunense (H. Syd. et P. Syd.) H. Syd. - Ann. Mycol. 13:378. 1915.
Basionym: *Phyllachora lagunensis* H. Syd. et P. Syd.
On *Ficus hauili*, Luzon, Philippines.

lindmani (Starb.) Theiss. et H. Syd. - Ann. Mycol. 13:395. 1915.
Basionym: *Phyllachora lindmani* Starb.
On Myrtaceae, Sa~o Paulo, Brazil.

lonchothecum (Speg.) Theiss. et H. Syd. - Ann. Mycol. 13:392. 1915.
Basionym: *Phyllachora lonchotheca* Speg.
On *Condalia lineata*, Argentina.

macroloculatum Chardon - Ann. Mycol. 32:113. 1934.
On *Ternstroemia* sp., Colombia.

macrosiphoniae (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:397. 1915.
Basionym: *Phyllachora macrosiphoniae* Henn.
On *Macrosiphonia* sp., São Paulo, Brazil.

maquilingianum H. Syd. et P. Syd. - Ann. Mycol. 14:364. 1916.
On *Ficus* sp., Mt. Maquiling, Philippines.

merrillii H. Syd. - Ann. Mycol. 21:101. 1923.
On *Ficus lucbanensis*, Mt. Pukis, Bontoc, Philippines.

microcentum (Berk. et Broome) Theiss. et H. Syd. - Ann. Mycol. 13:384. 1915.
Basionym: *Phyllachora microcenta* Berk. et Broome.
On *Ficus mysorensis*, Mysore, India.

microcentum (Berk. et Broome) Theiss. et H. Syd. var. ***graphica*** Theiss. et H. Syd. - Ann. Mycol. 13:385. 1915.
On *Ficus mysorensis*, Mysore, India.

microplacum Syd. - Philipp. J. Sci. 21(2):138. 1922.
On *Ficus sp.*, Amboina, Indonesia.

miryense (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:386. 1915.
Basionym: *Phyllachora myriensis* Henn.
On Annonaceae, Amazonas, Brazil.

mucosum (Speg.) Theiss. et H. Syd. - Ann. Mycol. 13:373. 1915.
Basionym: *Phyllachora mucosa* Speg.
On *Cocos australis*, Guarapi, Brazil.

myrciae (Lév.) Theiss. et H. Syd. - Ann. Mycol. 13:393. 1915.
Basionym: *Dothidea myrciae* Lév.
On *Myrcia* sp., Brazil.

myrrhinii (Theiss.) Theiss. - Ann. Mycol. 13:395. 1915.
Basionym: *Phyllachora myrrhinii* Theiss.
On *Myrrhinium rubriflorum*, Rio Grande do Sul, Brazil.

nigerrimum Viégas - Bragantia 4:139. 1944.
On *Campomanesia caerulea*, Brazil.

nipponicum H. Syd. et P. Syd. - Ann. Mycol. 13:40 et 379. 1915.
On *Ficus nipponica*, Amayi, Japan.

nitens (Lév.) Theiss. et H. Syd. Ann. Mycol. 14:447. 1916.
Basionym: *Sphaeria nitens* Lév.
On *Psoralea sp.*, Peru.

nitidissimum (Berk. et M. A. Curtis) Theiss. et H. Syd. - Ann. Mycol. 13:398. 1915.
Basionym: *Dothidea nitidissima* Berk. et M. A. Curtis.

On leaves of unidentified plant, Cuba.

ocoteae Stevens - Bot. Gaz. 69:251. 1920.
On *Ocotea leucoxylonis*, Mt. Alegrillo, Puerto Rico.

palmicola Stevens - Bot. Gaz. 69:251. 1920.
On *Thrinacis ponceanae*, Vega Baja, Puerto Rico.

panamensis Chardon - J. Dept. Agric. Porto Rico. 14:251. 1930.
On *Bauhinia* sp., Panama.

paramoense Chardon - Ann. Mycol. 32:113. 1934.
On *Vaccinium floribundum*, Colombia.

patouillardii Theiss. - Verh.-zool.-bot. Ges. Wien 69:13. 1919.
On coriaceous leaves of unidentified plant, Venezuela.

paulense (Rehm) Theiss. et H. Syd. - Ann. Mycol. 13:388. 1915.
Basionym: *Phyllachora paulensis* Rehm
On Leguminosae, São Paulo, Brazil.

peglerae Doidge - Bothalia 1(1):25. 1921.
On *Eugenia capensis*, South Africa.

phyllanthophillum (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:390. 1915.
Basionym: *Phyllachora phyllanthophila* Henn.
On *Phyllanthus* sp., Peru.

portoricensis Chardon - Mycologia 19:297. 1927.
On *Ficus stahlii*, Puerto Rico.

pterocarpi (H. Syd. et P. Syd.) H. Syd. - Ann. Mycol. 13:387. 1915.
Basionym: *Phyllachora pterocarpi* H. Syd. et P. Syd.
On *Pterocarpus angolensis*, Africa, on *P. saxatilis*, Java, and on *P. indicus*, Philippines.

puiggarii (Speg.) Chardon - J. Dept. Agric. Puerto Rico. 16(2):171. 1932.
Basionym: *Phyllachora puiggarii* Speg.
On Leguminosae ("folia parvula imparipinnata"), Apiahy, São Paulo, Brazil.

punctum (Cooke) Theiss. et H. Syd. - Ann. Mycol. 15:141. 1917.
Basionym: *Dothidea puncta* Cooke
On *Dalbergia armata*, Inanda, Natal, South Africa.

qualeae Viégas - Bragantia 4:141. 1944.
On *Qualea sp.*, Brazil.

ravenalae (Pat. et Har.) Theiss. et H. Syd. - Ann. Mycol. 13:283. 1915.
Basionym: *Phyllachora ravenalae* Pat. et Har.
On *Ravenala madagascariensis*, Madagascar.

renealmiae (Rehm) Theiss. et H. Syd. - Ann. Mycol. 13:375. 1915.
Basionym: *Phyllachora renealmiae* Rehm
On *Renealmia sp.*, Sta. Catharina, Brazil.

repens (Corda) Theiss. et H. Syd. - Ann. Mycol. 13:383. 1915.
Basionym: *Sphaeria repens* Corda
On *Ficus religiosa*, India.

rhopalinum (Mont.) Theiss. et H. Syd. - Ann. Mycol. 13:385. 1915.
Basionym: *Dothidea rophalina* Mont.

On *Rhopala guyanensis*, Cayenne, on *Rhopala sp.*, Brazil, Peru, and on *Rhopala brasiliensis*, Brazil.

rhopographiodes (G. Wint.) Viégas - Bragantia 4:143. 1944.
Basionym: *Phyllachora rhopographioides* G. Wint.
On *Pteris aquilina*, Brazil.

rimulosa (Speg.) Chardon - J. Dept. Agric. Puerto Rico 16(2):171. 1932.
Basionym: *Phyllachora rimulosa* Speg.
On *Myrcia oerstediana*, Costa Rica.

robinsonii H. Syd. - Philipp. J. Sci. 21(2):138. 1922.
On *Ficus sp.*, Amboina, Indonesia.

sabal Chardon - Farlowia 2:461. 1946.
On *Sabal sp.*, Dominican Republic.

sanguineum (Rehm) Theiss. et H. Syd. - Ann. Mycol. 13:379. 1915.
Basionym: *Phyllachora circinata* H. Syd. et P. Syd. var. *sanguinea* Rehm
On *Ficus heterophylla*, Los Banos, Luzon, Philippines.

schotiae Doidge - Bothalia 1(2):65. 1922.
On *Schotia speciosa*, South Africa.

schweinfurthii (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:377. 1915.
Basionym: *Phyllachora schweinfurthii* Henn.
On *Ficus palmata*, Erythrea, Ethiopia.

selenospora (Speg.) Chardon - Mycologia 32:188. 1940.
Basionym: *Phyllachora selenospora* Speg.
On Myrtaceae, Minas Gerais, Brazil.

semi-lunata Chardon - J. Dept. Agric. Porto Rico. 13:9. 1929.
On *Eugenia sp.*, Puerto Rico.

serjaniae (Speg.) Chardon - J. Dept. Agric. Puerto Rico. 16(2):170. 1932.
Basionym: *Phyllachora serjaniae* Speg.
On *Serjania caracasana*, Argentina.

serra-negrae Viégas - Bragantia 4:144. 1944.
On *Croton floribundus*, Brazil.

strychni H. Syd. - Leafl. Philipp. Bot. 9:3125. 1925.
On *Strychnus multiflora*, Irosin, Sorsogon, Philippines.

subcircinans (Speg.) Theiss. et H. Syd. - Ann. Mycol. 13:394. 1915.
Basionym: *Phyllachora subcircinans* Speg.
On Myrtaceae, Brazil, and on *Psidium cattleyanum*, Puerto Leon, Misiones, Argentina.

tephrosiae Chardon - Mycologia 32:188. 1940.
On *Tephrosia sp.*, Brazil.

torrendiella Batista - Bol. Agric. Pernambuco 15:132. 1948.
On *Cocos nucifera*, Viçosa, Brazil.

tropicalis (Speg.) Chardon - J. Dept. Agric. Puerto Rico 16(2):172. 1932.
Basionym: *Phyllachora tropicalis* Speg.
On *Psidium thea*, Argentina.

truncatisporum Viégas - Bragantia 4:145. 1944.
On Myrtaceae, Brazil.
ulceratum (Massee) Theiss. et H. Syd. - Ann. Mycol. 13:399. 1915.
Basionym: *Phyllachora ulcerata* Massee
On leaves of unidentified plant, New Guinea.
urbanianum (Allesch. et Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:394. 1915.
Basionym: *Phyllachora urbaniana* Allesch. et Henn.
On Myrtaceae, Goyaz, Brazil.
urbanianum (Allesch. et Henn.) Theiss. et H. Syd. forma ***curvulispora*** (Henn.) Theiss. et H. Syd. - Ann. Mycol. 13:395. 1915.
Basionym: *Phyllachora curvulispora* Henn.
On Myrtaceae, Morro Pellado, São Paulo, Brazil.
urophyllum (Hõhn.) Theiss. et H. Syd. - Ann. Mycol. 13:382. 1915.
Basionym: *Phyllachora urophylla* Hõhn.
On *Ficus urophylla*, Tjibodas, Java.
valsiforme (Rehm) Theiss. et H. Syd. - Ann. Mycol. 13:379. 1915.
Basionym: *Phyllachora valsiformis* Rehm
On *Ficus crassitora*, Luzon, Laguna, Los Banos, Philippines.
venezuelensis (H. Syd.) Chardon - J. Dept. Agric. Puerto Rico. 16(2):170. 1932.
Basionym: *Phyllachora venezuelensis* H. Syd.
On *Machaerium humboldtianum*, *M. moritzianum*, and *M. robiniaefolium*, Costa Rica, Trinidad, and Venezuela.
weirii Chardon - J. Dept. Agric. Porto Rico. 13(1):8. 1929.
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  caseariae
  dalbergiicola
  davillae
  distinguendum
  egregium
  feijoae
  flavo-cinctum
  forsteroniae
  fructigenum
  glaziovii
  gouaniae
  goyazense
  gracillimum
  lindmani
  macrosiphoniae
  miryense
  mucosum
  myrciae
  myrrhinii
  nigerrimum
  paulense
  puiggarii
  qualeae
  renealmiae
  rhopalinum
  rhopographiodes
  selenospora
  serra-negrae
  tephrosiae
  torrendiella
  truncatisporum
  urbanianum
Chile
  acaenae
Colombia
  cabalii
  macroloculatum
  paramoense
Congo
  grammicum
Costa Rica
  contractum
  costaricense
  costaricensis
  rimulosa

- *venezuelensis*
- *zanthoxyli*

Cuba
- *abieticum*
- *brittoniana*
- *cubense*
- *nitidissimum*

Dominican Republic
- *sabal*

Ethiopia
- *schweinfurthii*

Guadeloupe
- *dussiae*

Hispaniola (Santo Domingo)
- *amyridis*

Honduras
- *costaricense*

India
- *acaciae*
- *elaeocarpi*
- *elettariae*
- *himalayanum*
- *infectorium*
- *microcentum*
- *microcentum* var. *graphica*
- *repens*

Indonesia
- *decaisneanum*
- *microplacum*
- *robinsonii*

Japan
- *nipponicum*

Java
- *aspideum* f. *fici-albae*
- *euryae*
- *fici-obscurae*
- *urophyllum*

Madagascar
- *ravenalae*

Marquesas
- *exanthematica*

New Guinea
- *kambachii*
- *ulceratum*

North America
- *flabellum*

Panama
- *panamensis*

Peru
- *centrolobiicola*
- *galactiae*
- *nitens*
- *phyllanthophillum*
- *rhopalinum*

Philippines
- *apoense*
- *aspideum* f. *fici-fulvae*
- *aspideum* f. *spinifera*
- *circinatum*
- *dalbergiicola* var. *philippinensis*
- *dalbergiicola* var. *philippinensis* f. *conidiifera*
- *egenulum*
- *elmeri*
- *garciae*
- *lagunense*
- *maquilingianum*
- *merrillii*
- *pterocarpi*
- *sanguineum*
- *strychni*
- *valsiforme*

Puerto Rico
- *amyridis*
- *ingae*
- *ocoteae*
- *palmicola*
- *portoricensis*
- *semi-lunata*

South Africa (Natal)
  peglerae
  punctum
  schotiae
Sri Lanka (Ceylon)
  aspideum
  aspideum f.
    urostigamatis
      -tomentosi
Trinidad
  venezuelensis
Venezuela
  eugeniicola
  patouillardii
  venezuelensis
Yugoslavia
  dothidea

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AMANITA NEOOVOIDEA—TAXONOMY AND DISTRIBUTION

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Summary

An anatomical study of *Amanita neoovoidea* is reported. The range of the species is extended from central Japan to include Sichuan Province, China and Nepal. A summary of information about edibility of the species is provided.

Amanita neoovoidea Hongo. 1975. *Mem. Shiga Univ.* 25: 57, fig. 50.
Illus.: Hongo. 1978. *Trans. Myc. Soc. Jap.* 19: 456.
Illus.: Imazeki & Hongo. 1987. *Colored Illustrations.* 1: pl. 31, fig. 220.
Illus.: Imazeki, Otani & Hongo. 1988. *Fungi*: 160.

Amanita neoovoidea is a medium- to large-sized, mostly white to whitish mushroom the pileus of which is decorated with an unusual volva that includes a pulverulent layer upon which is superimposed a rather thick, membranous layer that has ochraceous or orangish tints. The greater part of this membranous volva is carried up by the expanding pileus leaving at most an irregular limb on the top of the stipe's basal bulb. The annulus is apical, rather thick, and friable.

PILEUS: 75 - 130$^+$ mm diam., white or off white becoming golden blonde (5C4[1]) in age, hemispherical to convex to planoconvex to depressed, at times with an umbo; margin appendiculate, slightly striate, at times rimose, slightly decurved; context white

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[1] Color codes of this form are from Kornerup & Wanscher (1978).

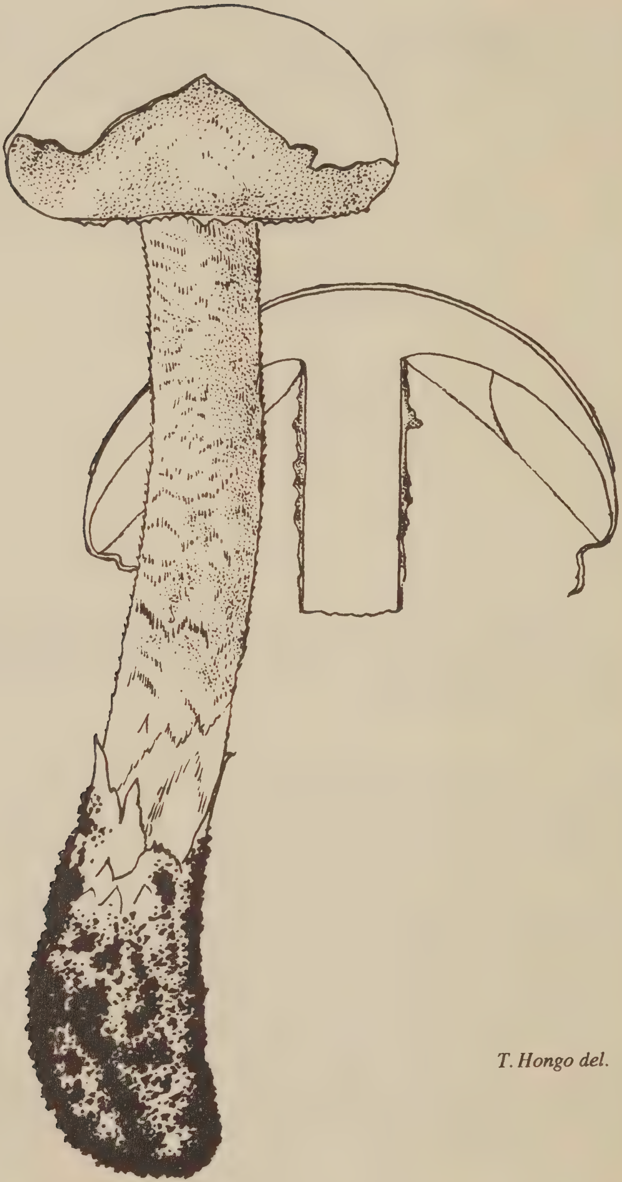
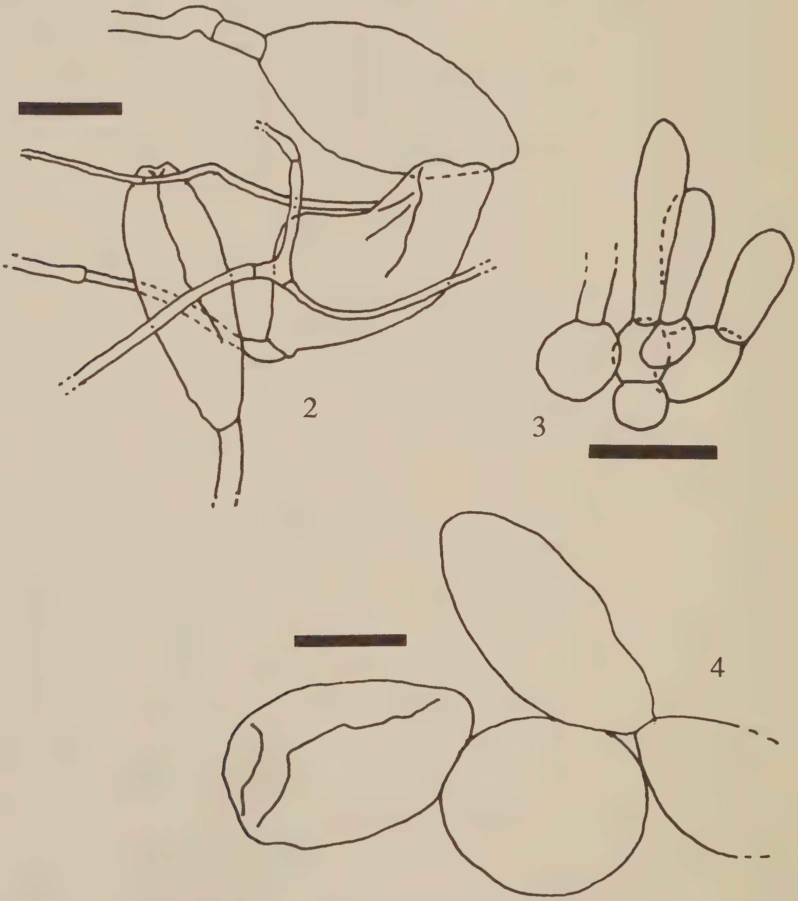


Fig. 1 *Amanita neoovoidea*. Habit: T. Hongo 6387 (complete specimen (×1.3)) and T. Hongo 4890 (in section (×0.85)).

to whitish, unchanging, somewhat tough, elastic, thinning gradually to margin; universal veil commonly as one or a small number of membranous patches, elastic, topaz to golden blonde to pale ochraceous (warm buff to cream-buff), occasionally lost, with underlying pulverulent layer adjacent to the pileipellis. LAMELLAE: pale cream to white to white with very slight rosy tint, free with decurrent line on stipe, close, thick, waxy, up to 7 - 10 mm broad, edges white and minutely flocculose to fibrillose becoming 5C4 in age, drying 6C7, crenate; lamellulae frequent, rounded attenuate. STIPE: 110 - 130 × 12 - 15 mm, white, becoming sordid on handling, flocculose-floccose-squamulose, narrowing upward, expanded at the apex; context white, solid; annulus white, rather thick, floccose-subfelted, friable, ephemeral, apical to superior, but collapsing down stipe; bulb ventricose to clavate to fusiform to napiform, often subradicating; universal veil membranous, in a few incomplete rings or limbate or entirely carried up on the pileus, pallid ochraceous (cream-buff) to orangish to deep orange on the outer surface. Odor penetrating, but agreeable. Taste mild. Popularly considered edible in both Japan and Nepal. Macrochemical spot tests: KOH - on universal veil, apricot; on stipe surface and flocculence, clay colored.

PILEIPELLIS: $30^{\pm}$ μm thick; filamentous, undifferentiated hyphae 1.0 - 5.5 μm diam., subradially arranged, interwoven, partially to entirely gelatinizing; oleiferous hyphae 0.8 - 10.5 μm diam., relatively common locally—especially near surface. PILEUS CONTEXT: filamentous, undifferentiated hyphae 2.0 - 7.5 μm diam., branching, loosely interwoven, occasionally with slightly thickened walls, with some segments inflated partially up to 25 μm diam. (such segments may be intercalary and even branching); inflated cells broadly clavate to ovoid to ellipsoid, up to 105 × 52 μm, with walls sometimes slightly thickened; oleiferous hyphae 1.5 - 3.0 μm diam. LAMELLA TRAMA: bilateral; filamentous, undifferentiated hyphae 1.2 - 6.5 μm diam.; inflated cells plentiful, broadly clavate to elongate to ellipsoid, up to 44 × 28 μm, with walls 0.5 - 1.0 μm thick; oleiferous hyphae scarce to locally common, 1.5 - 6.8 μm diam., branching, sometimes penetrating the subhymenium. SUBHYMENIUM: dominantly cellular; composed of rather large cells; most basidia arising from these large cells, with a few arising from smaller cells or barely inflated very short hyphal segments; branching, filamentous, undifferentiated hyphae penetrating this region, arising (at times) roughly perpendicular to the central stratum. BASIDIA: 32 - 40 × (7.0-) 7.8 - 11.8 μm, 4- or occasionally 2- or 1-sterigmate, thin-walled or with walls slightly thickened; sterigmata prominent; clamps not observed. UNIVERSAL VEIL: On the pileus, exterior surface: extensively gelatinizing, loosely interwoven hyphae at surface, below this having a layer about 30 - 40 μm thick consisting of filamentous, undifferentiated hyphae 1.5 - 5.2 μm diam., compactly interwoven; oleiferous hyphae 2.2 - 10.0 μm diam., infrequently branching, locally common. On the pileus, interior layer: somewhat loosely interwoven, filamentous, undifferentiated hyphae 1.8 - 11.0 μm diam., dominant; inflated cells scattered, cylindric to clavate to ellipsoid, up to 96 × 29 μm, thin-walled or with walls very slightly thickened, terminal; oleiferous hyphae 1.8 - 9.2 μm diam. On the pileus, inner pulverulent layer: filamentous, undifferentiated hyphae 1.5 - 7.5 μm diam., branching; inflated cells terminal or in short chains, subglobose to ellipsoid to clavate, up to 67 × 60 μm, dominating; oleiferous hyphae 1.0 - 5.2 μm diam., locally plentiful. On the stipe base: similar to that on pileus. STIPE CONTEXT: acrophysalidic; filamentous, undifferentiated hyphae 2.0 - 9.5 µm diam.; acrophysalides thin-walled, narrowly clavate, plentiful, up to 250 × 35 µm; oleiferous hyphae not common, 6.5 - 15.0 µm diam. PARTIAL VEIL: filamentous, undifferentiated hyphae 1.0 - 9.0 µm diam., loosely tangled, frequently branching, gelatinizing; inflated cells plentiful to dominant, terminal, clavate to ventricose, thin-walled, rather easily collapsing, up to 68 × 32 µm; oleiferous hyphae not observed. All tissues pale yellow in NH_4OH.



Figs. 2-4. *Amanita neoovoidea*. 2. Elements of partial veil (Hongo 5984). 3. Elements of hymenium and subhymenium from somewhat immature specimen (Hongo 3430). 4. Elements of pulverulent inner surface layer of universal veil from pileus (holotype). The bars in Figs. 2-4 represent 20 µm.

BASIDIOSPORES: [238 measured from 11 specimens from 9 collections] (5.8-) 6.8 - 9.8 (-12.0) × (4.2-) 4.8 - 6.5 (-7.5) µm, (average length per specimen = 6.9 - 8.9 (-9.8) µm; average length (overall) = 8.2 µm; average width per specimen = 5.3 - 6.1 (-6.4) µm; average width (overall) = 5.7 µm; Q = (1.19-) 1.25 - 1.64 (-2.25); average Q per specimen = (1.29-) 1.36 - 1.53; average Q (overall) = 1.43), hyaline, thin-walled, smooth, amyloid, occasionally adaxially flattened, broadly ellipsoid to ellipsoid to (occasionally) elongate or cylindric, occasionally pip-shaped; apiculus sublateral, small, truncate conic to cylindric; contents guttulate to granular; white in deposit.

Distribution and habitat: China: In mixed coniferous and broad-leaved forest in July at 700 m elev. Japan: In mixed forests of *Pinus densiflora* Sieb. & Zucc., *Quercus serrata* Thunb., etc., Ôtsu, July to October; in *Pinus-Quercus* forest, Takatsuki-city, September; in *Castanopsis cuspidata* (Thunb.) Schottky forest, Ise-Jingô, July; and in *Quercus* woods, Ôtani, Suzu-city, October. Usually associated with *Fagaceae*; Nagoya collection from *Pinus-Quercus* forest. Nepal: in troops in July in forest comprising *Symplocus pyrifolia* Wall., *Castanopsis tribuloides* A.DC., and *Quercus glauca* Thunb.

Hongo and Yokoyama (1978) divided Japanese Agaricales into nine groups based on global geographic distribution. *Amanita neoovoidea* clearly belongs to the Southeast Asiatic group which includes fungi occurring ''in evergreen, broad-leaved,...warm temperate forests'' ranging from western and central Japan (up to the northern limit of the ranges of deciduous members of the *Fagaceae*) to ''highlands of Southeast Asia (including the mountain sides of the Himalayas)....'' In the protologue of *A. neoovoidea*, Hongo lists Japanese sites (besides those represented by paratypes): Ôsaka, Shiga, Mie, Ishikawa, Tokyo, Miyagi, and Akita. Among presumed mycorrhizal symbionts are ''evergreen oaks, *Quercus* (*Cyclobalanopsis*), *Castanopsis*, *Lithocarpus*, etc.''

Collections examined: **CHINA**: SICHUAN—Weiyuan County - Xin Chang, 13.vii.1985 M. S. Yan 1040 (HKAS[2] 15868). **JAPAN**: *HONSHU*: AICHI-KEN—Nagoya-city - Meitô-ku, Makigaike-Ryokuchi, 7.ix.1975 T. Asai *s.n.* [Hongo 5392] (HONGO). ISHIKAWA-KEN—Suzu-city - Ôtani, 10.x.1974 Y. Ikeda *s.n.* [Hongo 5244] (paratype, HONGO). KYOTO-FU—Uji-city - Higashi-Kasadori, 13.viii.1982 T. Hongo 6387 (HONGO). MIE-KEN—Ise-city - Ise-Jingô (Naikô), 28.vii.1967 Hongo 3430 (paratype, TNS F-237227). SHIGA-KEN—Ôtsu-city - Ishiyama-Senjô, 24.viii.1973 Y. Sugiyama *s.n.* [Hongo 4890] (paratype, HONGO), 20.ix.1979 T. Hongo

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[2] The herbarium name abbreviations used in this paper are

HKAS - Herbarium of Cryptogams, Kunming Institute of Botany, Academia Sinica, Heilongtan, Kunming, Yunnan, China.
HONGO - Personal herbarium of T. Hongo, Ôtsu-City, Japan
L - Rijksherbarium, Leiden, The Netherlands
NHMTU - Herbarium, Natural History Museum, Tribhuvan University, Kathmandu, Nepal.
RET - Personal herbarium of R. E. Tulloss
TNS - Herbarium, National Science Museum, Tokyo, Japan

5984 (HONGO); Nango-Imodani, 12.ix.1980 T. Hongo 6195 (HONGO); Ishiyama-Terabe, 25.vii.1967 Hongo 3423 (holotype, TNS F-237226), 24.viii.1973 Y. Sugiyama *s.n.* [Hongo 4890a & 4890b] (paratype, HONGO - in 2 packets). **NEPAL**: CENTRAL DEVELOPMENT REGION—Bagmati Zone - Bhaktapur District, 10 km E of Bhaktapur City, Nala, 19.vii.1989 H. R. Bhandary *s.n.* (NHMTU & RET).

DISCUSSION

The appendiculate pileus margin, amyloid spores, and membranous volval limb place this entity in *Amanita* section *Amidella* (Gilbert) Konrad & Maublanc. The type of section *Amidella* is *A. volvata* (Peck) Lloyd of North America (Corner & Bas, 1962).

The North American taxa of section *Amidella* all have the tendency to turn reddish-brown after bruising or exposure to air; several have a striate pileus margin or develop one at maturity; the inner layer or layers of the universal veil are at least somewhat friable while the external surface is sturdy and membranous; the stipe is totally elongating—lacking a truly bulbous base; and the lamellulae of these species are truncate. Most of the European taxa of section *Amidella* exhibit these characters as well.

The relatively strong discoloring, totally elongating stipe, and truncate lamellulae are not characters of *A. neoovoidea*.

Hongo 6195 consists of a single specimen just expanding out of the ''button'' stage; it illustrates very clearly the presence of a true bulb in this species. Tissues from the broadest portion of the bulb are typical of *Amanita* stipe tissue (having a longitudinal orientation) and distinctly different from the more disordered tissue of the universal veil. This stands in direct contrast with the tissue in the apparent bulbs of such members of section *Amidella* as *A. lepiotoides* Barla of Europe and *A. volvata*.

Among the described species of *Amanita*, *A. neoovoidea* appears to be closest to *Amanita ovoidea* (Bull.:Fr.) Link. *Amanita ovoidea* was placed by Gilbert (1940-41) in the genus *Amidella* in its protologue, and later authors have not altered this assignment. While many taxa in section *Amidella* have truncate lamellulae, *A. ovoidea* has lamellulae that vary from truncate to obliquely attenuate (Malençon and Bertault, 1970). See also the protologue of the recently described *A. chepangiana* Tulloss & Bhandary (1992) which shares color change and universal veil characters with *A. ovoidea* and *A. neoovoidea* and has subattenuate to attenuate lamellulae, a totally elongating stipe, and a rather strongly striate p ileus margin.

Considering the above and considering that a complete review of all taxa previously assigned to section *Amidella* has not been done, it seems unwise to emend the section piecemeal or to propose subsectional taxa in this paper. Therefore, we simply highlight some interesting apparent relationships within the section.

Hatanaka and Kawakami (1980) report that *Amanita neoovoidea* contains a free amino acid (2-amino-4,5-hexadienoic acid) in about the same proportion previously reported by North American workers for *A. smithiana* Bas (protologue (Bas, 1969)). This amino acid has been demonstrated to be fatal to guinea pigs in doses of 100 mg per kg of body weight (Chilton *et al.*, 1973). In spite of the fact that, in the protologue of *A. neooovoidea*, Hongo notes that *A. neoovoidea* is popularly considered edible, Hatanaka and Kawakami recommend that it not be eaten. Bhandary has observed that the species is also considered edible in Nepal where it is cooked after removing the universal veil.

Since 1986, there have been several cases of suspected *A. smithiana* poisoning reported in the United States (Cochran, 1989; Lampe, 1989; Tulloss & Lindgren, ined.). In these poisonings, *A. smithiana* was occasionally eaten raw, but was often eaten after cooking (e.g., in a soup). Common factors in these cases include

— onset of symptoms in 4 to 10 hours including vomiting, diarrhea, and abdominal pain

— complete, but reversible, renal failure occurring within about two to three days of ingestion.

If indeed the free amino acid cited above is the toxic agent in *A. smithiana* and if it is also present in *A. neoovoidea*, why is it not toxic in *A. neoovoidea*? We considered the possibility that the means of preparation of *A. neoovoidea* might somehow remove or alter the toxic agent. However, it appears that no special preparations are taken against poison when *A. neoovoidea* is prepared for the table. For example, Shimizu (1988) describes experimentation by members of the Sendai amateur mycological club; their experience indicated the fungus was edible. Shimizu reports that a number of methods of preparation were found to be successful: sukiyaki, tenpura (frying), tsukeyaki (broiling), etc. Shimizu recommends that the fungus not be eaten in excess.

We were unable to examine one of the paratypes of *A. neoovoidea* (OSAKA-FU—Takatsuki-city - 29.ix.1974 T. Yokoyama *s.n.* [Hongo 5211] (TNS?)).

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We express our gratitude to the following persons who contributed to our ability to develop this paper: Dr. C. Bas (L) reviewed the paper and counseled us about sectional placement of *A. neoovoidea* (our conservative position on placement is directly due to his comments and advice); Dr. Y. Doi (TNS) for arranging loans of specimens; Ms. Mary A. King, Roosevelt, New Jersey, for assisting in preparing the paper for publication; Prof. Mu Zang and Dr. Zhu-Liang Yang (HKAS) for supporting us with a loan from their institution.

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APHYLLOPHORALES ON PINUS AND EUCALYPTUS IN ZIMBABWE

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ABSTRACT

71 species in 38 genera and 11 families were recorded on *Pinus* and *Eucalyptus*. 41 and 17 species were restricted to *Pinus* and *Eucalyptus* respectively. 40 species are new records for Zimbabwe. 10 species are reported from Africa for the first time. 63 species are saprotrophic, 9 are parasitic and one was mycorrhizal. The new combination, *Abortiporus roseus* (Reid) Masuka & Ryvarden, is proposed.

INTRODUCTION

Pinus and *Eucalyptus* species were introduced in Zimbabwe in the 1890s to meet the country's demands for sawn timber, pulp and paper, and poles. Coordinated planting started only in the 1950s and 1960s. Over 90 000 ha are currently planted with *Pinus* and *Eucalyptus* in Zimbabwe. *Pinus* is also increasingly being used for the construction of buildings.

Collections of fungi on indigenous trees in Zimbabwe date back to 1905 (Cheeseman, 1909), but the first collection of Aphyllophorales on exotic tree species was probably in the 1940s (Doidge, 1950). No systematic collection and identification of wood-inhabiting fungi has been carried out in the country. The object of the study was to conduct an inventory of parasites and saprotrophs on *Pinus* and *Eucalyptus*.

Wood-inhabiting Aphyllophorales were collected in January and October, 1990, and January, 1991, from 11 localities (Fig. 1). A total of 990 collections were made, of which 911 were determined, the rest being sterile or immature. The collections are deposited in the National Collection of Macrofungi University of Zimbabwe (formerly at CAH).

We have followed Ryvarden & Johansen (1980) and Ryvarden (1991) for nomenclature of the polypores, Hallenberg (1985) for Lachnocladiaceae and Ginns (1982) for Coniophoraceae. Resupinate to hydnoid species of Corticiaceae *s. str.* will be treated separately in a later publication. In this paper we report only on the poroid representatives of this family and species from the other recorded families of Aphyllophorales.

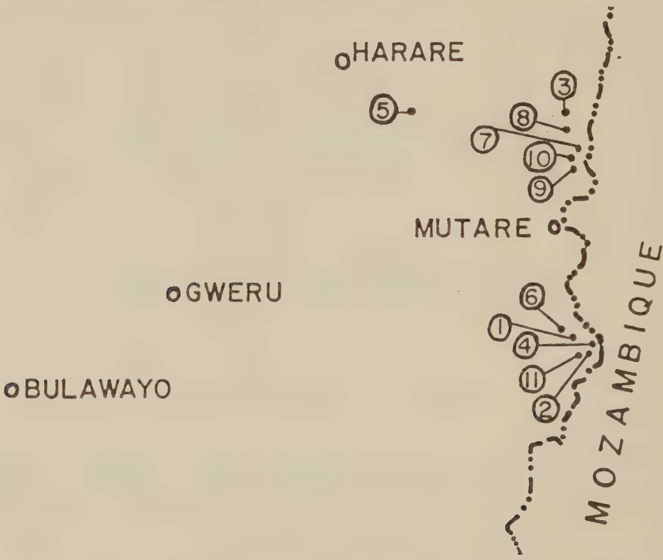

Fig. 1. Eastern Zimbabwe with the collection localities: 1 = Bridal Veil Falls; 2 = Chisengu; 3 = Erin; 4 = Forestry Services; 5 = Grasslands; 6 = Gwendingwe; 7 = Mukandi; 8 = Shamu; 9 = Sheba; 10 = Stapleford; 11 = Tarka.

LIST OF SPECIES, HOSTS, SUBSTRATA AND DISTRIBUTION

There is a paucity of Aphyllophorales records, apart from polypores, in Africa. Where we have not found records of the occurrence of a species, we assumed it to be previously unrecorded for the given area.

An asterisk following the name indicates that the species has not previously been recorded in Zimbabwe. Each name is followed by its host. The hosts are given in an alphabetical order, abbreviated as follows: Eg = *Eucalyptus grandis*; Em = *Eucalyptus maculata*; Ey = *Eucalyptus microcorys and* E = unidentified *Eucalyptus* sp.; Pp = *Pinus patula*; Pe = *Pinus elliottii*; Pt = *Pinus taeda.*

Coniophoraceae

Coniophora arida (Fr.) Karst. var. *arida* *
on bark, branches, logs: Pp 3 (AJM 476), 9 (AJM 162, AJM 552), 10 (AJM 265, AJM 816); Pe 2 (AJM 387); Pe, Pp, Pt timber used as stack stands: 2 (AJM 756).
Coniophora arida (Peck.) Ginns var. *suffocata* *
on branches, logs: Eg 3 (AJM 213); Pe 7 (AJM 306); Pp 2 (AJM 800), 9 (AJM 192b).
Coniophora fusispora (Cke. & Ell.) Sacc.
on Pp logs: 3 (AJM 870), 6 (AJM 422), 10 (AJM 04); new record for Africa.
Coniophora hanoiensis Pat. *
on logs: Pp 3 (AJM 207, AJM 869).
Coniophora olivacea (Fr.:Fr.) Karst. *
on branches, stems: Pp 3 (AJM 466), 6 (AJM 426), 7 (AJM 985), 9 (AJM 192a, AJM 564), 10 (AJM 522, AJM 815).
Coniophora submembranacea (Berk. & Br.) Sacc.
on log: Pp 7 (AJM 988); new record for Africa.
Coniophora puteana (Fr.) Karst. var. *incrustata* *
on burnt log: Pp 6 (AJM 420).
Coniophora puteana (Fr.) Karst. var. *puteana*
on branches, logs: Pp 10 (AJM 531); Pe 2 (AJM 801); Pt 8 (AJM 553).
Leucogyrophana pinastri (Fr.) Ginns & Weres. *
on logs in advanced decay: Pe 10 (AJM 533).
Serpula himantioides (Fr.:Fr.) Karst. *
on logs in advanced decay in humid environments: Pe 7 (AJM 297); Pp 10 (AJM 05, AJM 242, AJM 532, AJM 812).

Corticiaceae

Gloeoporus dichorus (Fr.) Bres.
on exposed stumps: Pp 3 (AJM 482, AJM 872).
Schizopora flavipora (Cooke) Ryv.
on bark, branches, stumps, logs: Em 4 (330, AJM 779); Ey 7 (AJM 966); Pt 11 (AJM 70); Pe 7 (AJM 517); Pp 2 (AJM 400), 3 (AJM 874), 9 (AJM 197, AJM 550), 10 (AJM 02, AJM 244a).
Schizopora paradoxa (Fr.) Donk
on bark, branches, stumps, logs: Em 4 (AJM 309, AJM 719); Ey 7 (AJM 496, AJM 986); Pp 2 (AJM 407, AJM 804), 3 (AJM 222, AJM 475), 10 (AJM 244b, AJM 809).
Sistotrema dennisii Malencon. *
on log in advanced decay: Pp 3 (R 23951).
Trechispora mollusca (Pers.: Fr.) Liberta *
on log in advanced decay: Em 4 (AJM 341).

Ganodermataceae

Ganoderma australe (Fr.) Pat.
on stumps: Pe 10 (AJM 262, AJM 806).

Hericiaceae
Laxitextum bicolor (Pers. : Fr.) Lentz *
parasitic on coppice stumps: Eg 5 (AJM 131); log: Em 4 (AJM 435); parasitic.

Hymenochaetaceae
Coltriciella dependens (Berk. & Curt.) Murr.
on buried logs: Pp 2 (AJM 372); new record for Africa.
Phellinus discipes (Berk.) Ryv.
parasitic on coppice stumps: Eg 5 (AJM 141), 8 (AJM 228, AJM 581); on debarked logs awaiting transportation to depot: Eg 4 (AJM 706); on logs: Em 4 (AJM 455, AJM 775); Ey 7 (AJM 279); E 1 (AJM 411).
Phellinus gilvus (Schw.) Pat.
parasitic on coppice stumps: Eg 5 (AJM 147, AJM 607); logs: Em 4 (AJM 311, AJM 626); causing heart-rot: Em 4 (AJM 328); on stump: Pp 10 (AJM 09).
Phellinus lamaensis (Murr.) Heim
underneath log: Pp 3 (R 23950)

Lachnocladiaceae
Asterostroma cervicolor (Berk. & Curt.) Mass. *
on bark, branches: Pt 2 (AJM 392).
Asterostroma ochroleucum Bres. & Torrend *
on burnt log: Eg 8 (AJM 234).
Asterostroma medium Bres. *
on branch: Pe 2 (AJM 379); new record for Africa.
Dichostereum effuscatum (Cke. & Ell.) Boid. & Lanq. *
on branch: Pe 2 (AJM 380, AJM 597).
Dichostereum kenyense Boid. & Lanq. *
on bark: Pe 2 (AJM 386).
Dichostereum orientale Boid. & Lanq. *
on logs: Em 4 (AJM 352); Pe 11 (AJM 86).
Dichostereum peniophoroides (Burt.) Boid. & Lanq.
on bark, branches: Pe 2 (AJM 393); new record for Africa.
Dichostereum ramulosum Boid. & Lanq. *
on branches, bark: Pp 2 (AJM 397, AJM 597); Pt 10 (AJM 259).
Scytinostroma ochroleucum (Bres. & Torrend.) Donk *
on log: Pt 11 (AJM 25).
Scytinostroma odoratum (Fr.) Donk *
on logs: Pt 2 (AJM 789), Pt 11 (AJM 43).
Varariasphaericospora Gilbn. *
on bark, branches: Pe 7 (AJM 302); Pt 10 (AJM 807).

Polyporaceae
Abortiporus roseus (Reid) Masuka & Ryvarden comb. nov. *
Basionym: *Heteroporus roseus* Reid., Microscopy 32: 449, 1975
Abortiporus Murr., being based on a monstrosity, was an illegitimate name

up to the Botanical Congress in St. Petersburg (formerly Leningrad) in 1975. The article on monstrosities was then removed and *Abortiporus* regained its priority over *Heteroporus* Laz. Both genera are typified by the same species, viz. *A. biennis* (Bull.:Fr.) Singer. We confirm that the variation in the occurrence of gloeocystidia reported by Ryvarden & Johansen (1980) is a common feature among specimens of this species,
parasitic: Eg 5 (AJM 16b); parasitic on coppice stumps: Eg 7 (AJM 493).

Amylonotus africanus Ryv.
on logs: Ey 7 (AJM 280).

Antrodia albida (Fr.) Donk
on logs: Pe 2 (AJM 383); Pt 3 (AJM 11).

Antrodia gossypina (Speg.) Ryv. *
on logs in advanced decay: Ey 7 (AJM 276); logs: Pp 6 (AJM 121).

Antrodia heteromorpha (Fr.) Donk *
on branch: Pp 3 (AJM 218).

Antrodia malicola (Berk. & Curt.) Donk *
parasitic on coppice stumps: Eg 8 (AJM 579); on dead stumps, logs: Eg 5 (AJM 130), Eg 8 (AJM 845); Em 4 (AJM 353, AJM 454); Pp 3 (AJM 14).

Antrodia oleracea (Davids. & Lombard) Ryv. *
on log: Pp 6 (AJM 118).

Antrodia sinuosa (Fr.) Karst. *
on burnt logs: Eg 8 (AJM 849); Pp 8 (AJM 156); on timber used as stack stands: Pe, Pp, Pt 2 (AJM 754); on logs: Pp 10 (AJM 263).

Antrodia vaillantii (Fr.) Ryv. *
on timber used as stack stands: Pe, Pp, Pt 2 (AJM 755).

Antrodia xantha (Fr.) Ryv.
on burnt log: Pp 3 (AJM 203); new record for Africa.

Ceriporia viridans (Berk. & Br.) Donk
on log: Pe 10 (AJM 245a).

Ceriporiopsis aneirina (Sommerf. : Fr.) Donk
on logs in advanced decay: Pp 8 (AJM 565, AJM 832); Pt 2 (AJM 374); new record for Africa.

Coriolopsis polyzona (Pers.) Ryv.
on log: Pt 7 (AJM 300).

Cristelloporia dimitica Johan. & Ryv. *
on bark in humid environment: Ey 7 (AJM 962).

Diplomitoporus lenis (Karst.) Gilbn. & Ryv. *
on logs in advanced decay: Pe 2 (AJM 375).

Flavodon flavus (Kl.) Ryv.
on debarked logs awaiting transportation to depot: Eg 4 (AJM 780).

Junghunia crustacea (Jungh.) Ryv.
on branch tip: Eg 8 (AJM 176).

Lentinus villosus Klotzsch
on log: Eg 8 (AJM 238).

Nigroporus vinosus (Berk.) Murr.
underneath logs: Pp 8 (AJM 182, AJM 557, AJM 828).

Perenniporia subacida (Peck.) Donk
parasitic on coppice stumps: Eg 8 (AJM 576, AJM 850).

Polyporus arcularius Batsch.: Fr.
on log: Pe 8 (AJM 181).
Polyporus virgatus Berk. & Curt.
on log: Ey 7 (AJM 964).
Pycnoporus sanguineus (Fr.) Murr.
on exposed logs, bark, branches: Em 4 (AJM 361, AJM 607); Pe 2 (AJM 405), 7 (AJM 298, AJM 516); Pp 10 (AJM 03).
Rigidoporus lineatus (Pers.) Ryv. *
on log ends: Pe 7 (AJM 289, AJM 514, AJM 984).
Rigidoporus vinctus (Berk.) Ryv. var. *vincta*
on logs, bark: Pt 10 (AJM 808).
Skeletocutis amorpha (Fr.) Kotl. & Pouz. *
on logs, bark: Pp 2 (AJM 431); new record for Africa.
Skeletocutis nivea (Jungh.) Kl.
on bark: Em 4 (AJM 339); logs: Pp 3 (AJM 871); Pt 11 (AJM 80).
Skeletocutis percandida (Malenc. & Berk.) Kl. *
on bark: Pp 10 (AJM 95).
Trametes menziesii (Berk.) Ryv.
on logs, branches: Ey 7 (AJM 281); Em 4 (AJM 632).
Trametes pocas (Berk.) Ryv.
on logs, branches: Eg 8 (AJM 171); Em 4 (AJM 354, AJM 741); variable morphology - pores 2-6 per mm -, and spore size - 4-6.5 x 2.5-3.5 -, probably a complex of species.
Trametes versicolor (L.:Fr.) Pil.
on logs, branches: Em 4 (AJM 310, AJM 609, AJM 746); Ey 7 (AJM 562); Pp 6 (AJM 125).
Wrightoporia africana Ryv.
on logs: Pe 2 (AJM 406).
Wrightoporia avellanea (Bres.) Pouz. *
on logs: Pp 3 (AJM 865).
Wrightoporia cinammomea Ryv.
on log: Pe 2 (AJM 388a); new record for Africa.

Schizophyllaceae
Schizophyllum commune Fr.
on bark, branches, logs (burnt or not): Eg 5 (AJM 416); Pp 6 (AJM 117), 9 (AJM 154), 10 (AJM 252).

Steccherinaceae
Steccherinum ochraceum (Fr.) S.F. Gray
on debarked logs awaiting transport to depot: Eg 4 (AJM 323, AJM 728); on logs: Pe 7 (AJM 295).

Stereaceae
Stereum hirsutum (Willd.:Fr.) S.F. Gray
on branch tips on living tree: Eg 5 (AJM 134); parasitic on coppice stumps: Eg 5 (AJM 144a), 8 (AJM 226, AJM 577); on branches, logs: Em 4 (AJM

308, AJM 452, AJM 611); Ey 7 (AJM 274, AJM 512).

Stereum illudens Berk.
on bark, branches: Eg 8 (AJM 172); Em 4 (AJM 307, AJM 610); E 1 (AJM 412); new record for Africa.

Stereum ostrea (Blume & Nees.: Fr.) Fr.
parasitic on coppice stumps: Eg 5 (AJM 133); on branches, logs: Eg 8 (AJM 225, AJM 578); Em 4 (AJM 612).

Stereum sanguinolentum (Alb. & Schw.: Fr.) Fr. *
on logs, bark, branches: Pe 7 (AJM 303); Pp 3 (AJM 206), 10 (AJM 246, AJM 814); Pt 2 (AJM 373).

Thelephoraceae

Thelephora terrestris Ehrh. : Fr.
on stumps: Pp 3 (AJM 211), 9 (AJM 186, AJM 558); on bases of seedlings: Pe, Pp 7 (AJM 990); mycorrhizal.

DISCUSSION

Among the polypores there is a much higher proportion of brown-rot fungi in the temperate and boreal zones than in the tropical zone (see Gilbertson & Ryvarden, 1986, and Ryvarden 1991). It the boreal to temperate zones the brown rotting polypores constitute from 18 to 25% of the total number, while the correspnding number is approximately 2% in East Africa. 65 to 75% of the brown rot polypores occur exclusively or predominantly on coniferous hosts (see Ryvarden 1991), varying somewhat variable from one continent to another.

If we look at the species reported in this paper, 16 species are brown rotting, i.e. 22% of the total number. The brown rotting species are found in Coniophoraceae and the polyporoid genus *Antrodia*.

It is remarkable to note that so many brown rotting species have been established in plantations in Zimbabwe, far away from their natural habitats, i.e. the circumpolar boreal to temperate zones. There are three possible explanations for this disjunct distribution.

The species are omnipresent as anamorphs, but only produce a teleomorphic stage on certain hosts when they are available, eventually correlated to some climatic conditions. This theory is purely speculative and unsubstantiated.

The spore dispersal mechanisms of these species are more effective than assumed. Thus, the African trees might have been infected through long distance dispersal from Europe, for example, where all the reported brown rot species occur in natural forests.

If this is true, it may be asked why all polypores, not just the brown rotting species, are not more or less cosmopolitan. All the spores of the reported *Antrodia* spp. are hyaline and thin-walled. Many white rot polypores have similar spores and have a far more restricted distribution. Many are not even circumpolar in the boreal zone where there is a more or less continuity with suitable hosts from Europe through Asia to North America. This question is discussed in detail by Ryvarden (1991) and the reader is referred to this paper for a detailed discussion of the mycogeography of the polypores.

We therefore find the long distance dispersal theory to be improbable and reject it. An establishment by such a dispersal mechanism would have taken place within 100 years since plantations were established in Southern Africa.

We believe that most probably, the brown-rot species were introduced with their hosts. *Pinus* species have an obligate mycorrhizal association. The first pine introductions in south Central Africa were unsuccessful until soil was brought in from mature plantations elsewhere (Mikola, 1980). Originally the soil came from the natural areas of distribution of the planted *Pinus* species, viz. Central and North America. Later plants were introduced from other tropical plantations which again had their plants from different parts of the world. The soil introduced with such plants have probably been contaminated by spores and/or hyphae of the brown-rot species mentioned above.

The recorded white-rot fungi are also present in indigenous forests and the majority were recorded on *Eucalyptus*, an angiosperm, just like the indigenous hosts. This is expected, being a reflection of a lack of host specialisation, and possession of a versatile metabolism seen in most tropical white-rot fungi.

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TAXONOMIC STUDY OF SOME SPECIES OF THE GENUS ERYSIPHE

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After analyzing the characteristics of the respective anamorphs and teleomorphs, fifteen from the most common species of the genus *Erysiphe* are submitted to a binary comparison using the Dice-Sørensen similarity index and then to processing with the cluster analysis. In the resulting dendrogram, it is possible to identify groups of species connected together by a high level of similarity. Based on such results, the following changes in status are proposed: *Erysiphe pisi* DC., *E. buhrii* U. Braun, *E. urticae* (Wallr.) Blumer, *E. cruciferarum* Opiz *ex* Junell, and *E. heraclei* DC. become varieties of *E. pisi* DC.; while *E. artemisiae* Grev., *E. cynoglossi* (Wallr.) Braun, and *E. sordida* Junell become varieties of *E. artemisiae* Grev.

Introduction

The classification of the genus *Erysiphe* DC., as obviously the classifications of the genera of the same family (*Erysiphaceae*), has suffered from either a "broadened" or a "narrowed" concept of species, adopted by individual authors ever since the classic monograph by Salmon (1900), in which the concept of "broadened" predominates, up to the very recent monograph by Braun (1987), in which, on the contrary, we find the concept of "narrowed".

Zheng and Chen (1981) recently stated that, although these pathogens are widely distributed and have been known for some time, their taxonomy is still rather confused.

Such different points of view are manifest in the shifting delimitations between the species comprised in a genus and in the different hierarchization of their morphological characteristics, which is subjective, even though some basic characteristics have prevailed (type of conidiophore, number of spores per ascus, in the case of the genus under study).

Such changes in the nomenclature have a negative effect on the interpretation of the literature, and the geographical, ecological, and matrical references of the individual systematic entities are often difficult to compare. Thus, any classification should, as far as possible, reduce subjectivity, simultaneously using and comparing as many characteristics as possible.

Finally, contrary to what occurs for other groups of fungi, *Erysiphaceae* have the advantage that, in the majority of cases, the whole cycle of the fungus is known, which facilitates inserting them in a taxonomic classification.

Aim

The aim of this work is to try and provide a basis for classification, taking into account the foregoing comments and using numerical taxonomy, i.e., submitting the following fifteen species of *Erysiphe*, selected from those most widely found (at least in Europe) on plants of interest to agriculture, to a phenetic analysis of similarity.

Materials and Methods

In order to know the characteristics of each of the species considered, the leading monographs on the family in general and on the genus in particular have been consulted. Reference has also been made to the original descriptions (when clear and useful), to the literature on the subject (when available), to a substantial amount of original material collected in Italy, in particular, but abroad as well and, finally, to herbarium collections of different origins. The quantitative characteristics of the original specimens have been obtained with a Kontron MOP Videoplan image analyzer connected to a Zeiss microscope.

As specified further, the characteristics used are both qualitative and quantitative, with the latter appropriately subdivided into classes.

The following species have been selected:

- *E. aquilegiae* DC. Taken, as per Braun (1987), i.e., from the union of *E. aquilegiae* s.s. and *E. ranunculi* Grev. On *Ranunculaceae* throughout Europe, Asia, America, Africa, and Australia.
- *E. artemisiae* Grev. Enucleated from the group of *E. cichoracearum*, and easily distinguishable from it. On *Artemisia* and other *Compositae* of Europe, Asia, and North America.
- *E. betae* (Vanha) Weltzien. On various species of the genus *Beta* throughout the world.
- *E. buhrii* U. Braun. A recently described species, distributed on *Caryophyllaceae* throughout Europe, Asia, North America, and North Africa. Enucleated from the large group of "*E. communis*".
- *E. cichoracearum* DC. Species having hundreds of hosts throughout the world.
- *E. circaeae* Junell. Limited species enucleated from the group of *E. communis* and only on the genus *Circaea* in almost all Europe and Asia.
- *E. convolvuli* DC. Very common on different species of the genus *Convolvulus* and distributed world-wide.
- *E. cruciferarum* Opiz *ex* Junell. Common on *Cruciferae* and in moderation on *Papaveraceae* and *Capparidaceae* throughout the world.
- *E. cynoglossi* (Wallr.) U. Braun (corresponding to *E. asperifolium* Grev. and *E. horridula* Lév.). On *Boraginaceae* throughout the world.
- *E. depressa* (Wallr.) Schlecht. Small species enucleated from the group of *E. cichoracearum* DC and only on some *Compositae* (particularly of the genus *Arctium*) throughout Europe, Asia, and North America.
- *E. heraclei* DC. Common on *Umbelliferae* throughout the world.
- *E. pisi* DC. A species widespread on very many species of *Leguminosae* throughout the world.

- *E. polygoni* DC. Widespread on *Polygonaceae* throughout the world.
- *E. sordida* Junell. Limited species enucleated from the group of *E. cichoracearum* DC. and only on the species of the genus *Plantago* throughout the world.
- *E. urticae* (Wallr.) Blumer. On *Urticaceae* of all Europe and Asia.

We thus have a total of fifteen species.

The characteristics used to build up the basic matrix of data are those normally considered in the description of the anamorphs (genus *Oidium* Link) and teleomorphs.

They are listed by group:

- mycelium (distribution on plant organs, density, and dimensions of the hyphae);
- appressoria (type);
- foot-cells of the conidiophore [distance of the basal septum from the carrier hypha, shape, width, and height (commonly called length)];
- successive cells of the conidiophore (number, their relative height and that with the basal cell, dimensions);
- conidia (length, width, l/w ratio, shape, distribution on the conidiophore);
- cleistothecia (distribution, density, diameter);
- peridium (shape and dimensions of cells);
- appendages [origin with respect to the carpophore, length, width, length relative to the respective carpophore, type, their interrelationship and relationship with the mycelium, their development, number, color, external surface (whether smooth or rough), wall thickness, number of possible septae, type of branching];
- asci (whether pedunculate or sessile, length, width, number per cleistothecium);
- spores (shape, color, length, width, l/w ratio, number per ascus).

With regard to the quantitative characteristics, the mean, minimum, and maximum values were considered, as well as the typical values in the case of the diameter of the cleistothecium.*

For each species, a total of 81 groups of characteristics (of which 29 on anamorph and 52 on teleomorph), with a total possibility of 399 single characteristics (of which 153 on anamorph and 246 on teleomorph), was examined.

Each species was compared with each one of the others, connecting them two-by-two using the Dice-Sørensen index of similarity, which, in this case, was considered the most suitable (Biondi, 1985), in relation to 100. Processing was then carried out using the cluster analysis of the 15 OTUs. The characteristics have not been weighted so as not to subjectively influence the analysis itself.

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* Typical values are those comprised between the two amounts obtainable by substracting and respectively adding the value of the standard deviation from the mean value (cfr. Blumer, 1967).

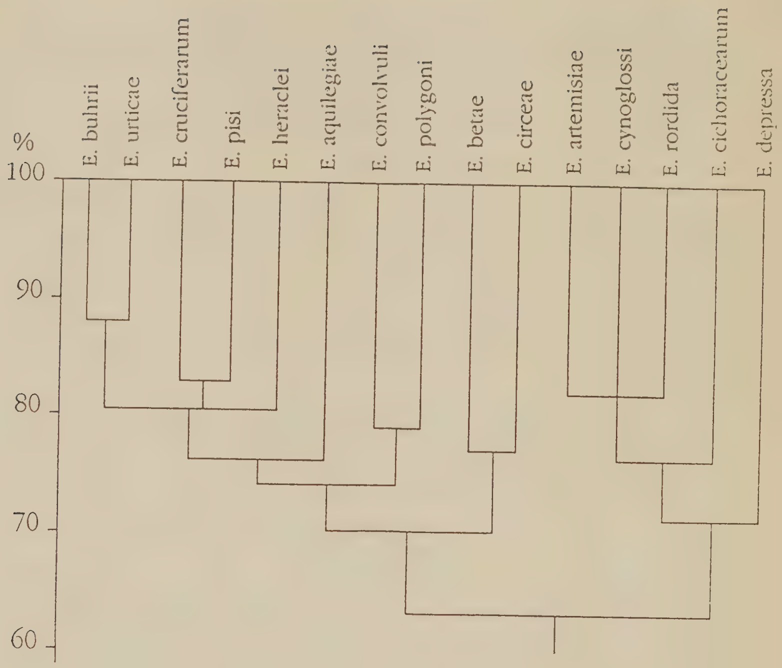

Fig.1 Dendrogram. The value of the similarity indices is shown on the left.

Results and Discussion

The dendrogram resulting from the comparison with the data collected and analyzed is reported in Fig. 1.

Beginning with the lowest phenetic levels of similarity (in this case 63%), the dendrogram is clearly divided into two clusters: the one on the left is formed of 10 species, the one on the right of 5 species. The 10 species on the left all belong to the section *Erysiphe*, the 5 on the right to the section *Golovinomyces* U. Braun. In other words, the numerical analysis confirms the usual subdivision of Blumer (1967) of the genus *Erysiphe* into the section *Linkomyces* and the section *Euerysiphe*.

After all, what Blumer realized practically on the basis of only two characteristics (type of conidiophore and number of spores per ascus) has now been confirmed by the whole collection of characteristics.

At the 70% level, in the group of the section *Erysiphe*, a cluster of two species (*E. betae* and *E. circeae*) breaks away. Such dichotomy merits separate study.

Going towards the highest levels, we obtain further confirmation: at the 71% level, *E. depressa* breaks away from the group of *E. cichoracearum*. For the former, Braun (1981) created a subsection of the section *Golovinomyces*, naming it, precisely, *subsection Depressa*.

A certain similarity can be noted (at the 77% phenon) between the two species *E. betae* and *E. circaeae*. Good similarity (79%) is clear between *E. convolvuli* and *E. polygoni*.

If we maintain that for a total of 399 possible characteristics, a similarity index higher than 80% makes it almost impossible to differentiate between two or more species, but only between simple varieties, the following synonymy is proposed:

In the left-hand cluster, there are five species connected together beyond such a level, specifically:

- *E. buhrii* U. Braun 1978;
- *E. urticae* (Wallr.) Blumer 1933;
- *E. cruciferarum* Opiz. *ex* Junell 1967;
- *E. pisi* DC. 1805;
- *E. heraclei* DC. 1815.

The species resulting from the fusion of the above five species will be named, in order of priority, *Erysiphe pisi* DC., while the five pre-existing species will be considered as varieties, according to the following division:

- var. *pisi*;
- var. *heraclei* (DC.) mihi stat. nov. [Syn.: *E. heraclei* DC., Fl. Fr. VI, p. 107 (1815)];
- var. *urticae* (Wallr.) mihi stat. nov. [Syn.: *E. urticae* (Wallr.) Blumer, Beitr. Krypt-Fl. Schweitz 7 (1), p. 224 (1933)];
- var. *cruciferarum* (Junell) mihi stat. nov. [Syn.: *E. cruciferarum* Opiz *ex* Junell, Sv. Bot. Tidskr. 61 (1), p. 217 (1967)];
- var. *buhrii* (U. Braun) mihi stat. nov. [Syn.: *E. buhrii* U. Braun, Ceska Myk. 32 (2), p. 80 (1978)].

Analogously, in the right-hand cluster there are three species connected together above 80%, specifically:

- *E. artemisiae* Grev. Fl. Edin. p. 459 (1924);
- *E. cynoglossi* (Wallr.) Braun 1982 (= *E. asperifolium* Grev., Fl. Edin. p. 461 (1824);
- *E. sordida* Junell, 1965.

The species resulting from the fusion will be named *Erysiphe artemisiae* Grev., while the three pre-existing species will be considered varieties, according to the following scheme:

- var. *artemisiae*;
- var. *cynoglossi* (Wallr.) mihi stat. nov. [Syn.: *E. cynoglossi* (Wallr.) U. Braun, Mycotaxon 15, p. 136 (1982)];

- var. *sordida* (Junell) mihi stat. nov. [Syn.: *E. sordida* Junell, Trans. Br. mycol. Soc. 48, p. 544 (1965)].

Conclusions

Applying the numerical taxonomy and the phenetic analysis on 15 species of *Erysiphe*, the following can be concluded:

1) Confirmation of two sections of the genus *Erysiphe*: *sectio Erysiphe* and *sectio Golovimomyces* U. Braun.
2) Confirmation of the *subsectio Depressa* U. Braun.
3) The species *E. buhrii* U. Braun, *E. urticae* (Wallr.) Blumer, *E. cruciferarum* Opiz *ex* Junell, *E. pisi* DC., and *E. heraclei* DC. are united in a single species, *E. pisi* DC. The species named are reduced to the rank of variety of the last species.
4) The species *E. artemisiae* Grev., *E. cynoglossi* (Wallr.) U. Braun and *E. sordida* Junell are united in a unique species, *E. artemisiae* Grev. The species named are reduced to the rank of variety of the last one.

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CHEMOTAXONOMIC SIGNIFICANCE OF FATTY ACID COMPOSITION IN THE GENUS MORTIERELLA (ZYGOMYCETES, MORTIERELLACEAE)

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SUMMARY

The fatty acid composition of 18 isolates in *Mortierella* subgen. *Micromucor* and 50 isolates in *Mortierella* subgen. *Mortierella* were analyzed by gas-liquid chromatography to explore the chemotaxonomic significance of fatty acid composition in the taxonomy and the identification of the genus *Mortierella.* The fatty acid composition appeared to be a useful chemotaxonomic marker in the genus *Mortierella* at the subgeneric level. Two subgenera were clearly distinguished from each other by their fatty acid composition; polyunsaturated C20 acids were detected only in *Mortierella* subgen. *Mortierella* isolates. The qualitative similarity in fatty acid composition between *Mortierella* subgen. *Micromucor* and mucoraceous fungi could offer supportive evidence for the determination of the true taxonomic position of the subgen. *Micromucor.* It is very interesting from the taxonomical, phylogenetic, and ecological point of view that polyunsaturated C20 acids were present in *Mortierella* species which is saprophytic and one of the most common soil fungi.

KEYWORDS: *Mortierella* , *Mortierella* subgen. *Micromucor, Mortierella* subgen. *Mortierella* , Zygomycetous fungi, Fatty acid composition, Chemotaxonomy

INTRODUCTION

Following Turner's recognition of *Mortierella isabellina* group (Turner, 1963), Gams (1977) subdivided the genus *Mortierella* into two subgenera, *Micromucor* and *Mortierella* in his key to the species of the genus *Mortierella.* They are distinguished from each other mainly by their morphological and cultural characteristics. The former subgenus is mainly characterized by its rather-slow growing, velvety colony with pigmented sporangia, on the other hand, the latter is mainly characterized by thin, spreading mycelium with hyaline sporangia and a garlic-like odour. His subdivision of *Mortierella* into two subgenera is now widely accepted. Several species of the subgen. *Micromucor* have distinctly *Mucor*-like characteristics (Benjamin, 1979), but they were tentatively placed in the genus *Mortierella.* The true taxonomic position of the subgen.

Micromucor is at present uncertain because of the absence of a known sexual stage, though von Arx (1983) raised the subgen. *Micromucor* to generic rank and placed it in the Mucoraceae sensu von Arx.

Shinmen et al. (1989) briefly mentioned that two subgenera of *Mortierella* clearly differed from each other in their fatty acid composition on the basis of their analysis of fatty acid composition of five isolates in subgen. *Micromucor* and five isolates in subgen. *Mortierella*. Their report suggested the usefulness of fatty acid composition as chemotaxomic characteristic in the taxonomy and the identification of the species of *Mortierella*.

Thus we further determined the fatty acid composition of 18 isolates in subgen. *Micromucor* and 50 isolates in subgen. *Mortierella* to explore the chemotaxonomic significance of fatty acid composition in the genus *Mortierella* .

MATERIALS AND METHODS

Microorganisms: Eighteen isolates assigned to *Mortierella* subgen. *Micromucor* and 50 isolates assigned to *Mortierella* subgen. *Mortierella* were used in this study. Names, culture collection number, and isolated source are listed in Table 1.

Culture media and growth condition: Stock cultures were maintained on slants of YM agar [1% (w/v) yeast extract (Difco), 1%(w/v) malt extract (Difco), 1%(w/v) glucose, 1.6% (w/v) agar, pH 6.0]. To obtain material for fatty acid extraction, the isolates were grown in liquid medium containing 2%(w/v) glucose and 1%(w/v) yeast extract(Difco). The pH of the medium was adjusted to 6.0 before the medium was autoclaved at 15 kgf/cm^2 for 15 min. In all cases 10 ml Erlenmeyer flasks with 2 ml of sterile medium were inoculated with mycelium scraped from the stock slant. After 4 to 7 days of incubation with reciprocal shaking at 28°C, mycelium was harvested by filtration. The mycelium was washed well with distilled water and then dried under vacuum in a centrifugal evaporator (RD-41, Yamato Co., Tokyo, Japan) at 50 to 60° C.

Extraction of fatty acids and preparation of methyl esters: The dried mycelium was suspended in 1 ml of methylene chloride, followed by the addition of 1 ml of 10% HCl in methanol. The mixture was boiled in a water bath for 2 to 3 h. Fatty acid methyl esters were extracted with 4 ml of n-hexane, and then the extract was concentrated under vaccum in a centrifugal evaporator at 30 to 40° C.

Fatty acid analysis: The fatty acid methyl esters were dissolved in 10 µl of acetonitrile and analyzed by gas liquid chromatography (GC09A, Shimadzu Corporation, Kyoto, Japan) on glass column (2m × 3 mm i.d.) packed with 15% diethylene glycol succinate on a 60/80 mesh Neopak 1A (Nishio Kogyo, Tokyo, Japan) equipped with a flame ionization detector. The gas carrier was nitrogen at a flow rate of 40 ml/min. Operation temperature of injection was 250°C with column isothermal at 210°C. Quantitative estimates of the areas under the peaks were obtained with the aid of an integrator (C-R3A, Shimadzu Corporation, Kyoto, Japan). Peak identification was made using fatty acid methyl ester standards and comparing them to the peaks in the sample.

RESULTS

The fatty acid composition of 18 isolates in subgen. *Micromucor* are presented in Table 2. The major fatty acids in all isolates studied were C16:0, C18:1, C18:2, and γ-C18:3. C18:0 was detected as a minor component in all isolates studied. Concentration of C18:1 was the highest of the four major fatty acids ranging from 36 to 46% of the total fatty acids in all isolates except for *M. ramanniana* var. *ramanniana* CBS 112.08. Unlike the other isolates, *M. ramanniana* var. *ramanniana* CBS 112.08 contained γ-C18:3 at 24% of the total fatty acids together with C16:0, C18:1, and C18:2 at 20.3%, 21.4%, and 19.8%, respectively. The polyunsaturated C20 acids were characteristically not detected in all isolates studied.

The fatty acid composition of 50 isolates in subgen. *Mortierella* are presented in Table 3. The polyunsaturated C20 acids were clearly detected in all isolates studied. C20:4 was detected in all isolates studied; C20:3 was also detected in most isolates together with C20:4; moreover, in five isolates traces or small amounts of C20:5 were also detected. In most isolates of subgen. *Mortierella* , either C18:1 and C20:4 or C18:1 and C16:0 represented the major fatty acids, while in *M. alpina* CBS 608.70, C16:0 and C20:4, and in *M. reticulata* CBS 223.29, C18:1 and C18:2 represented the major fatty acids, respectively. It is noted herewith that C20:4 constituted about 70% of the total fatty acids in *M. alpina* CBS 527.72. It is interesting that the level of γ-C18:3 in the isolates of subgen. *Mortierella* was lower than that in the isolates of subgen. *Micromucor* (3-12% vs 10-24%). The fatty acids C22:0 and C24:0 were detected in all isolates in subgen. *Mortierella* , though they are not listed in Table 3. They constituted about 5% of the total fatty acids.

The fatty acid C12 was not detected in all isolates examined in the present study. Traces or small amounts of C14:0 were detected in all isolates, though it is not listed in Tables 2 and 3.

DISCUSSION

Two subgenera of the genus *Mortierella* are distinguished from each other by their morphological and cultural characteristics (Gams, 1977). Shinmen et al.(1989) pointed out that two subgenera also differed from each other in their fatty acid composition; polyunsaturated C20 acids were detected only in the isolates of subgen. *Mortierella* but never detected in those of subgen. *Micromucor*. Our present analysis of the fatty acid composition of 18 isolates in subgen. *Micromucor* and 50 isolates in subgen. *Mortierella* confirmed their results. The difference of their fatty acid composition coincided with that of the morphological and the cultural characteristics.

Gams (1977) grouped the species of subgen. *Mortierella* into nine sections on the basis of the type of sporangiophore ramification. We analysed the fatty acid composition of 50 isolates in subgen. *Mortierella* assigned to seven sections. There appeared to be no correlation between the fatty acid composition and the type of sporangiophore ramification. Fatty acid composition appears to be a useful chemotaxonomic marker in the genus *Mortierella* at the subgeneric level.

Although the subgen. *Micromucor* has *Mucor*-like characteristics, its true taxonomic position is still uncertain because the zygospores have not been discovered in this subgenus (Gams, 1977; Benjamin, 1979). Comparison of the fattty acid composition of mucoraceous fungi so far reported (Lösel, 1988) and that of the isolates in subgen. *Micromucor* obtained in this study showed that fatty acid composition of subgen. *Micromucor* was qualitatively similar to that of mucoraceous fungi: the predominant fatty acids were C16:0, C18:1, and C18:2; γ-C18:3 was presented; polyunsaturated C20 acids were never detected. More detailed chemotaxonomic as well as morphological studies are necessary before coming to a conclusion, but it is considered that the qualitative similarity in the fatty acid composition of the mucoraceous fungi and the isolates of subgen. *Micromucor* offer supportive evidence for the determination of the true taxonomic position of the subgen. *Micromucor*.

In zygomycetous fungi other than *Mortierella* species, the presence of polyunsaturated C20 acids were reported in *Entomophthora* species and *Conidiobolus* species (Tyrrell, 1967, 1971) and *Gigaspora margarita* and *Glomus* species (Jabaji-Hare, 1988). The former are usually parasitic on insects and the latter are symbionts of higher plants; on the contrary, *Mortierella* species are saprophytic and belong to the most common soil fungi. It is very interesting from the taxonomical, phylogenetic, and ecological point of view that all these fungi have the ability to biosynthesize fatty acids longer than C18, although their habitats are remarkably different from one another.

The fatty acid composition of the fungi belonging to the Entomophthorales was shown to be useful as an aid to determining their true taxonomic position (Tyrrell, 1967 , 1971). In this study we also clarified that the fatty acid composition was a useful chemotaxonomic characteristic in the taxonomy and the identification of the genus *Mortierella*. Chemotaxonomic characteristics such as the fatty acid composition, the ubiquinone system, and G+C content of DNA may also provide valuable information to establish a more rational taxonomic scheme of zygomycetous fungi.

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Table 1. List of isolates used in this study

Taxon	Isotate[1)]	Source
Subgenus *Micromucor*		
Mortierella isabellina	CBS 194.28	
Mortierella isabellina	IFO 6336	Soil
Mortierella isabellina	IFO 7824	
Mortierella isabellina	IFO 7873	Wood of *Betula* sp.
Mortierella isabellina	IFO 7874	Germany
Mortierella isabellina	IFO 8286	Soil, Waipoua, New Zealand
Mortierella isabellina	IFO 8308	Soil, Cradle Mountain National Park, Tasmania
Mortierella isabellina	NRRL 1757	
Mortierella nana	IFO 8190	Soil, Cradle Mountain National Park, Tasmasnia
Mortierella ramanniana var. *angulispora*	IFO 5426	Forest soil
Mortierella ramanniana var. *angulispora*	IFO 8186	Soil, Blue Mountain, N.S.W., Australia
Mortierella ramanniana var. *ramanniana*	CBS 112.08	Soil, Scotland, UK
Mortierella ramanniana var. *ramanniana*	CBS 212.72	Forest soil, Sweden
Mortierella ramanniana var. *ramanniana*	IFO 7825	
Mortierella ramanniana var. *ramanniana*	IFO 8184	Soil, Blue Mountain, N.S.W., Australia
Mortierella ramanniana var. *ramanniana*	IFO 8185	Soil, Cradle Mountain National Park, Tasmania
Mortierella ramanniana var. *ramanniana*	IFO 8287	Soil, Te Anau, New Zealand
Mortierella vinacea	CBS 236.82	Root of *Fragaria* sp., Japan
Subgenus *Mortierella*		
Section *Alpina*		
Mortierella alpina	ATCC 16266	Soil, Germany
Mortierella alpina	ATCC 42430	Alpine eutric brunisol, grassy slope, Canada
Mortierella alpina	CBS 219.35	
Mortierella alpina	CBS 224.37	Soil, Hungary
Mortierella alpina	CBS 250.53	
Mortierella alpina	CBS 343.66	Tundra soil, Peters Lake, Alaska, U.S.A.
Mortierella alpina	CBS 527.72	Pasture soil, North Carolina, U.S.A.
Mortierella alpina	CBS 529.72	Pasture soil, North Carolina, U.S.A.
Mortierella alpina	CBS 608.70	Agricultural soil, Netherlands
Mortierella alpina	CBS 754.68	Heavily manured soil, India
Mortierella alpina	IFO 8568	Tundra soil, Peters Lake, Alaska, U.S.A.
Section *Hygrophila*		
Mortierella bainieri	IFO 8569	Tundra soil, C. Thompson, Alaska, U.S.A.
Mortierella beljakovae	CBS 123.72^{T}	Soil, USSR
Mortierella beljakovae	CBS 601.68	Bark of *Pinus* stump, North Carolina, U.S.A.
Mortierella clonocystis	CBS 357.76^{T}	Soil, Spain
Mortierella dichotoma	CBS 221.35ST	Dung of mouse, Germany
Mortierella elongata	CBS 121.71	Soil, Georgia, U.S.A.
Mortierella elongata	CBS 125.71	Soil, Georgia, U.S.A.
Mortierella elongata	NRRL 5513	Soil, Georgia, U.S.A.
Mortierella epigama	CBS 489.70^{T}	Municipal waste, Germany
Mortierella epigama	NRRL 5512^{T}	Municipal waste, Germany
Mortierella gemmifera	CBS 134.45^{T}	Pine forest soil, England, UK
Mortierella hyalina	CBS 654.68	Dung of deer, India
Mortierella hyalina	NRRL 6427	
Mortierella kuhlmanii	CBS 157.71^{T}	Stump of *Pinus palustris*, South Carolina, U.S.A.
Mortierella minutissima	CBS 226.35	Germany

Table 1 (Continued)

Mortierella minutissima var. *dubia*	CBS 307.52ST	Soil, Germany
Mortierella minutissima	IFO 8573	Soil, Lake Peters, Alaska, U.S.A.
Mortierella sarnyensis	CBS 122.72^{T}	Soil, Ukraine, USSR
Mortierella selenospora	CBS 811.68^{T}	Mushroom compost, Netherlands
Mortierella zychae	CBS 316.52^{T}	Decaying wood of *Populus tremula*, Germany
Section *Mortierella*		
Mortierella oligospora	CBS 218.72	Greenhouse soil, Netherlands
Mortierella polycephala	IFO 6335	Soil
Mortierella reticulata	CBS 223.29	
Section *Schmuckeri*		
Mortierella camargensis	CBS 221.58^{T}	Sandy soil, France
Mortierella schmuckeri	CBS 295.59ST	Soil under *Opuntia* sp., Mexico
Mortierella schmuckeri	NRRL 2761	
Section *Simplex*		
Mortierella globulifera	CBS 417.64	Soil, Germany
Mortierella rostafinskii	CBS 522.70^{NT}	Soil under *Pinus elliottii* var. *elliottii*, Georgia, U.S.A.
Section *Spinosa*		
Mortierella acrotona	CBS 386.71^{T}	Soil, India
Mortierella cystojenkinii	CBS 456.71^{T}	Agricultural soil, Netherlands
Mortierella pulchella	CBS 440.68	Bark and wood of *Pinus* stump, south carolina, U.S.A.
Mortierella umbellata	CBS124.71^{T}	Cultivated soil, Georgia, U.S.A.
Section *Stylospora*		
Mortierella horticola	CBS 305.52ST	Germany
Mortierella lignicola	CBS 313.52	Soil under *Pinus sylvestris*, Germany
Mortierella stylospora	CBS 211.32^{T}	Sandy loam, Victoria, Australia
Mortierella verticillata	CBS 220.58	Soil under *Betula* sp., France
Mortierella verticillata	IFO 8575	Tundra soil, Umiat, Alaska, U.S.A.
Mortierella verticillata	NRRL 6337	
Mortierella zonata	CBS 228.35^{T}	*Gomphidius glutinosus*, Germany

[1] T, strain derived from the type isolate; ST, strain derived from the syntype isolate, NT, strain derived from the neotype isolate. Culture collection: CBS, Centrralbureau voor Schimmelcultures, Baarn; IFO, Institute for Fermentation, Osaka; NRRL, USDA, Northern Regional Research Center, Peoria.

Table 2. Fatty acid composition of 18 *Mortierella* subgen. *Micromucor* isolates

			Fatty acid compositon (%)						
Strain	16:0	18:0	18:1	18:2	18:3	20:3	20:4	20:5	others
Mortierella isabellina CBS 194.28	15.6	1.9	40.0	17.5	22.9	--	--	--	2.1
Mortierella isabellina IFO 6336	17.5	2.0	39.0	17.7	20.6	--	--	--	3.2
Mortierella isabellina IFO 7824	16.3	2.6	38.3	17.9	21.7	--	--	--	3.2
Mortierella isabellina IFO 7873	21.4	3.3	42.8	13.3	15.4	--	--	--	3.8
Mortierella isabellina IFO 7874	16.6	1.7	50.2	16.1	11.5	--	--	--	3.9
Mortierella isabellina IFO 8286	17.8	4.3	44.1	13.0	17.6	--	--	--	3.2
Mortierella isabellina IFO 8308	18.6	3.2	51.9	11.6	10.0	--	--	--	4.7
Mortierella isabellina NRRL 1757	20.9	3.3	49.5	15.8	6.9	--	--	--	3.6
Mortierella nana IFO 8190	21.1	4.8	45.9	17.5	9.8	--	--	--	0.9
Mortierella ramanniana var. *angulispora* IFO 5426	25.2	5.4	35.7	14.3	17.6	--	--	--	1.8
Mortierella ramanniana var. *angulispora* IFO 8186	19.5	3.8	38.5	23.7	13.6	--	--	--	0.9
Mortierella ramanniana var. *autotrophica* CBS 212.72	16.4	1.7	41.1	25.0	13.2	--	--	--	2.6
Mortierella ramanniana var. *ramanniana* CBS 112.08	20.3	4.4	21.4	19.8	31.4	--	--	--	0.1
Mortierella ramanniana var. *ramanniana* IFO 8184	19.4	3.9	40.1	19.0	15.0	--	--	--	2.6
Mortierella ramanniana var.*ramanniana* IFO 8287	21.2	4.0	39.7	16.1	16.3	--	--	--	2.7
Mortierella ramanniana var.*rramanniana* IFO 7825	17.6	4.0	35.3	24.6	17.2	--	--	--	1.3
Mortierella ramanniana var. *rramanniana* IFO 8185	17.8	3.0	41.7	19.0	15.0	--	--	--	3.5
Mortierella vinacea CBS 236.82	18.1	2.2	46.3	11.4	22.0	--	--	--	--

Table 3. Fatty acid composition of 50 *Mortierella* subgen. *Mortierella* isolates

Strain	16:0	18:0	Fatty acid composition (%)					20:5	others1)
			18:1	18:2	18:3	20:3	20:4		
Section *Alpina*									
Mortierella alpina ATCC 16266	10.0	5.9	24.9	7.1	7.7	4.6	39.6	--	0.2
Mortierella alpina ATCC 42430	13.6	7.3	14.3	12.0	7.7	6.5	38.3	--	0.3
Mortierella alpina CBS 219.35	11.2	4.0	30.5	14.4	10.9	4.1	22.4	--	1.7
Mortierella alpina CBS 224.37	14.2	5.9	16.2	10.8	8.9	5.9	38.1	--	--
Mortierella alpina CBS 250.53	14.5	5.9	27.8	11.4	7.4	4.0	27.1	--	1.9
Mortierella alpina CBS 343.66	15.3	6.0	23.9	11.8	8.7	5.7	28.6	--	--
Mortierella alpina CBS 527.72	6.6	8.1	6.9	4.9	3.8	--	69.7	--	--
Mortierella alpina CBS 529.72	12.8	9.9	13.9	7.0	6.0	3.1	47.3	--	--
Mortierella alpina CBS 608.70	20.3	6.7	10.4	7.4	6.3	--	48.0	--	0.9
Mortierella alpina CBS 754.68	13.8	7.4	10.2	6.3	4.7	5.6	52.0	--	--
Mortierella alpina IFO 8568	18.8	7.9	28.1	9.2	7.9	6.5	20.9	--	0.7
Section *Hygrophila*									
Mortierella bainieri IFO 8569	20.8	7.8	31.2	6.6	5.8	5.4	21.5	--	0.9
Mortierella beljakovae CBS 123.72	15.5	11.8	44.3	6.5	5.8	3.7	10.4	--	2.0
Mortierella beljakovae CBS 601.68	10.9	4.2	28.3	16.6	12.4	5.5	19.1	--	3.0
Mortierella clonocystis CBS 357.76	13.6	6.3	42.7	9.9	4.6	2.9	18.7	--	1.3
Mortierella dichotoma CBS 221.35	17.5	8.0	30.5	7.8	3.5	2.5	11.3	--	18.4[a]
Mortierella elongata CBS 121.71	19.0	12.0	33.3	7.3	7.4	4.9	14.3	tr	1.8
Mortierella elongata CBS 125.71	15.4	14.0	30.3	6.7	6.0	3.8	21.7	tr	2.1
Mortierella elongata NRRL 5513	17.1	8.3	32.8	7.4	6.5	3.6	22.8	tr	1.5
Mortierella epigama CBS 489.70	16.8	5.1	27.4	8.2	9.8	4.6	23.0	0.9	4.2
Mortierella epigama NRRL 5512	15.1	5.1	28.7	9.1	12.1	4.5	23.3	0.8	1.3
Mortierella gemmifera CBS 134.45	19.3	8.8	38.7	8.1	6.8	2.5	10.6	--	5.2
Mortierella hyalina CBS 654.68	22.5	6.7	36.5	9.6	7.3	3.1	14.4	--	--
Mortierella hyalina NRRL 6427	17.3	12.9	29.3	7.4	7.5	3.3	11.3	0.2	10.8[b]
Mortierella kuhlmanii CBS 157.71	19.5	14.2	23.9	5.4	5.0	4.0	17.0	tr	11.0[c]
Mortierella minutissima CBS 226.35	16.2	5.2	33.0	13.2	4.7	2.4	24.3	--	1.0

Mortierella minutissima var. *dubia* CBS 307.52	8.1	2.9	22.5	20.1	12.4	4.1	30.0	--	--
Mortierella minutissima IFO 8573	16.1	8.3	23.9	9.6	8.4	4.1	14.3	0.4	14.9[d]
Mortierella sarnyensis CBS 122.72	24.1	9.9	33.0	12.3	3.4	2.0	15.3	--	--
Mortierella selenospora CBS 811.68	18.5	11.5	36.6	5.5	5.7	--	22.2	--	--
Mortierella zychae CBS 316.52	23.2	12.6	29.3	8.7	6.0	3.3	16.3	--	0.6
Section *Mortierella*									
Mortierella oligospora CBS 218.72	22.6	7.4	34.8	9.7	5.9	--	19.7	--	--
Mortierella polycephala IFO 6335	8.2	0.8	18.3	13.0	14.9	3.3	20.1	--	21.3[e]
Mortierella reticulata CBS 223.29	10.4	4.3	38.2	22.6	8.2	--	16.2	--	0.1
Section *Reticulata*									
Mortierella camargensis CBS 221.58	17.5	5.0	36.4	12.2	7.9	2.4	17.6	--	1.0
Mortierella schmuckeri CBS 295.59	26.3	8.8	33.9	8.7	3.1	2.9	15.9	--	0.4
Mortierella schmuckeri NRRL 2761	19.9	12.4	37.1	7.4	4.9	4.9	12.4	tr	1.0
Section *Simplex*									
Mortierella globulifera CBS 417.64	20.9	4.9	51.7	5.4	4.9	1.8	9.4	--	1.0
Mortierella rostafinskii CBS 522.70	21.9	5.1	26.3	13.4	5.9	3.3	22.6	--	1.5
Section *Spinosa*									
Mortierella acrotona CBS 386.71	27.8	8.1	41.9	4.7	4.0	2.7	10.2	--	0.6
Mortierella cystojenkinii CBS 456.71	18.7	6.1	48.2	4.4	3.1	2.6	16.2	--	0.7
Mortierella pulchella CBS 440.68	15.1	2.8	39.9	9.4	3.7	3.1	22.6	--	3.4
Mortierella umbellata CBS124.71	17.3	6.8	23.1	8.1	8.8	5.8	30.1	--	--
Section *Stylospora*									
Mortierella horticola CBS 305.52	18.6	6.5	25.7	13.3	8.1	3.5	24.4	--	--
Mortierella lignicola CBS 313.52	18.8	6.0	38.0	15.1	3.8	2.9	14.0	--	1.4
Mortierella stylospora CBS 211.32	16.7	11.0	33.6	11.6	7.5	3.8	15.8	--	--
Mortierella verticillata CBS 220.58	15.7	4.2	28.2	7.9	11.8	4.7	27.5	--	--
Mortierella verticillata IFO 8575	14.9	5.6	29.7	12.1	6.0	4.8	25.7	--	1.2
Mortierella verticillata NRRL 6337	13.6	6.8	36.4	6.7	6.9	5.4	23.0	--	1.2
Mortierella zonata CBS 228.35	38.0	9.9	24.3	8.0	3.9	2.9	12.9	--	0.1

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1)a C15:0 (5.8%), C17:0(9.2%), C17:1(3.4%); b C15:0(3.3%), C17:0(7.5%); c C20:1(10.5%), C20:2(0.5%); d C15:0(4.1%), C17:0(7.3%), C17:1(2.2%), C19:0 (1.3%); e C15:0(4.3%), C17:0(9.8%), C17:1(5.8%), C19:0(1.4%).

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SOME NOTES ON THE TAXONOMY AND NOMENCLATURE OF FIVE EUROPEAN ARMILLARIA SPECIES

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ABSTRACT

Recent nomenclatural publications on the names of the annulate European species A. ostoyae, A. cepistipes and A. gallica are discussed. Reasons for the rejection of the name A. obscura for the species A. ostoyae, of the names A. bulbosa and A. lutea for the species A. gallica and of A. cepistipes forma pseudobulbosa are given.

KEYWORDS: Armillaria ostoyae, A. cepistipes, A. gallica, nomenclature.

INTRODUCTION

In 1978 the Finnish mycologist K. Korhonen demonstrated the existence of five annulate Armillaria species in Europe with the help of biological tests (= mating tests performed in laboratory culture): he designated them the species A, B, C, D and E. However, in the literature more than 50 specific epithets associated with Armillaria mellea s.lat. have been published.

By studies on the morphology of tested basidiomes the five biological species recognised by Korhonen have been identified (Marxmüller 1982, Romagnesi and Marxmüller 1983, Marxmüller 1987) to represent the following species: Armillaria borealis Marxmüller & Korhonen (species A), A. cepistipes Velenovský (species B), A. ostoyae (Romagnesi) Herink (species C), A. gallica Marxmüller & Romagnesi (species E.) and A. mellea (Vahl : Fr.) Kummer (species D).

Below some further comments on questions which have often been asked in relation to our publications on the Armillaria taxonomy and nomenclature.

DISCUSSION

SPECIES C

Which of the two names should be used: Armillaria obscura (Schaeffer 1774) Herink 1973 or Armillaria ostoyae (Romagnesi 1970) Herink 1973 ?

Termorshuizen and Arnolds (1984, 1987) as well as Watling (1987) proposed as a result of extensive historic investigations that A. obscura be rejected for nomenclatural and taxonomic reasons. One of them concerns the interpretation of the plate 74 in Jacob Christian Schaeffer`s "Fungorum Icones ..." (1762), which they considered ambiguous. Several points ought to be considered:

1. The original copper plate was engraved by G. P. Nußbiegel and coloured by S. Loibel (probably later when the book was bound). Considering the time spent on an engraving, it is unlikely that the colours were painted in direct relation to the natural colour.
2. The description accompanying the plate 74 (1762) says : "it is a bicoloured fungus, mostly isolated, big but not very fleshy and not various; with a cap that is initially conic or convex, later rounded (arched), frequently pointed at its center and which presents always hairy scales; with a round (cylindrical?) stipe, somewhat inflated at its base; with a membranous "spore-cover" (veil) and a similar annulus."
3. The globose spores on the picture do not match Armillaria spores. As in this book the spores of other fungi are differentiated

and mostly correspond to the species represented, the argument that they are stylised is not very convincing.

4. Watling (1987) points out the lack of scales on the ring, margin and stipe.

I fully agree that it is not possible to correlate unequivocally Schaeffer`s fungus with Korhonen`s species C, which may perhaps not even be an Armillaria. Therefore, I also propose that A. obscura is to be regarded as a nomen ambiguum and should not be used for any fungus.

SPECIES B

What about A. cepistipes and its forma pseudobulbosa ?

The collections of species B that we found together with H. Romagnesi in Löffingen (Schwarzwald = Black Forest, Germany) on the 21st of September 1982 closely matched with Velenovský`s 1920 description of A. cepistipes. Previously we had examined only a limited number of species B collections which had larger and darker coloured basidiomes, which we had called "A. pseudobulbosa". Therefore the specimens from Löffingen looked on first impressions somewhat abnormal. To assist in the determination we created the two formae (Romagnesi and Marxmüller 1983). Additional collections revealed however that intermediate forms between A. cepistipes forma cepistipes and A. cepistipes forma pseudobulbosa are common. Thus it was necessary to abandon the designation of forms.

As we had been informed by Czechoslovakian mycologists that the type-specimen of A. cepistipes was lost, we proposed a neotype for A. cepistipes (1983). Three years later the holotype specimen was found by Antonín in the Velenovský herbarium in Prague (PRC). It was conserved in a formaldehyde, acetic acid and water solution. Antonín confirmed the identity with the "neotypus" specimen from Löffingen (Antonín 1986).

What is the correct orthography of "Armillaria cepaestipes"?

"Cepaestipes" is an orthographic mistake which should be corrected (Art. 73.8 of the I.C.B.N.; Greuter et al. 1988). According to the rule of compound noun formation in Latin phonetics, each short vowel which is moved from the end into the middle of a word must be changed into an i when followed by a vowel or one consonant, and (generally) into an e (short) when followed by several consonants (Romagnesi 1986). Therefore the correct orthography should be cepestipes.

However, following the proposal by Prof. T. Ahti, Helsinki (pers. comm.), and using as a pattern the Latin word "lectisternum", provided as an example by Romagnesi, I believe that "cepistipes" is acceptable and has been adopted here. It is also in accordance with the Recommendation 73 G of the Code.

SPECIES E

Why has the name Armillaria bulbosa (Barla) Velenovský been changed ?

Earlier (e.g. in Marxmüller 1982) the species E was referred to A. bulbosa. Barla (1887:143) described Armillaria mellea var. bulbosa and published a colour plate of this fungus (Barla 1888-pl 22, figs. 3 - 7). In addition, he left dried specimens (NICE, Barla herbarium), notes and an original water colour plate painted by Fossat. All these data revealed a greater resemblance of Barla`s fungus to the species B than to the species E. The supposition that var. bulbosa could be the species B was confirmed by ecological information such as the mountain habitat (France, Alpes-Maritimes, Bois de la Mairis, col de Turini, alt.1550 m) and the occurrence under conifers (Holdenrieder 1986, Guillaumin 1986).

If A. mellea var. bulbosa Barla 1887 and A. cepistipes Vel. 1920 are considered as synonymous, Velenovský`s name must have priority over Barla`s at species level.

In 1927 Velenovský raised var.bulbosa to the species level and in 1973 Romagnesi published Armillariella bulbosa (Barla) Romagnesi.

Romagnesi did not know at that time about the existence of two very similar species. His description was documented by specimens he collected near Compiègne (Oise) and Saint Sauveur-le-Vicomte (Manche). These specimens have been shown to be conspecific with species E, because later tested collections from these regions never revealed species B, which seems to occur rarely at low elevations (Guillaumin 1986). However, Romagnesi`s name Armillariella bulbosa was a misapplication for species E because it is based on Barla`s description. Thus Romagnesi and Marxmüller (1987) proposed for species E the new name Armillaria gallica . Mistakenly we cited Armillariella bulbosa (Barla) Romagnesi as basionym (H. Kreisel, oral communication). It is rather a "pseudobasionym", but as we had clearly mentioned that we accepted neither the typus of Barla, nor Romagnesi`s combination, the mistake does not justify changing the name gallica. (T. Ahti, pers. communication; see also Art. 63.2 of the I.C.B.N. [Kreisel, in litt.]).

Antonín (1990), who studied the Armillaria type specimens of Velenovský herbarium, believes that several species described by Velenovský (A. praecox, A. robliniensis and A. inflata) might be identical with A. gallica or A. cepistipes. However, the material Antonín used for investigation (two field sketches, a specimen later deposited by Velenovský instead of the lost type specimen, and one specimen in poor condition) is not sufficient to allow a reliable determination. Therefore, those names are regarded as nomina ambigua. Even in fresh condition A.gallica and A.cepistipes are often difficult to distinguish.

What is Armillaria lutea Gillet 1874 ?

This name was proposed for the species E by Termorshuizen and Arnolds (1984, 1987). As a precautionary measure they have not corroborated it by neotypification. Watling (1987) also used this name, but later discarded it (Watling, in litt.). Unfortunately two of these publications and mine (Marxmüller 1987), in which the name A. gallica was proposed for the same species, overlapped.

Gillet`s diagnosis describes specimens which were probably deformed at the margin by lack of moisture, as he mentions that the margin is "*fissured*". As we have observed that some Armillaria which usually have cylindrical bases swell during dry periods, the characteristic of an "enlarged" stipe base may not be used with certainty to determine the species. In Gillet`s diagnosis the main characteristic, the annulus, was qualified as "*pointing upwards*" (mistakenly interpreted as "fugaceous" by Termorshuizen), but only A. mellea has a persistent funnel shaped ring. The gills are described as "*decurrent*" (as in A. mellea, A. borealis, A. cepistipes); according to Gillet the "*depressed cap*" (all the species, but least on A. gallica) could be either "ochraceous" (A. borealis, A. ostoyae, A. gallica, A. cepistipes) or "*greenish* *yellow*" (so far only seen on A. mellea) or "reddish brown" (A. ostoyae, A. gallica). The stipe is noted as "incurved and covered with ochraceous flocs" (A. gallica, A. cepistipes, A. borealis, A. ostoyae) and the cap "decorated with small brown scales, becoming less numerous at the margin" (observed on A. gallica, A. borealis, A. ostoyae, A. cepistipes) and presenting "yellowish veil flocs on the margin" (A. borealis, A. gallica, A. cepistipes, sometimes A. ostoyae). The diagnosis also mentions: "*solitary or in small groups*" (A. cepistipes, A. borealis, in some cases A. gallica and A. ostoyae).

No further evidence is available to identify the fungus - no specimen, no type locality, no plate and no complementary notes. Romagnesi supposed that it might be a diagnosis of several Armillaria species collected at the same time.

Thus we declared A. lutea Gillet as a nomen ambiguum.

Which of the three names should be taken for species E ?

As A. bulbosa has been rejected as a misapplication and A. lutea has been declared as a nomen ambiguum, A. gallica is the only valid name for Korhonen`s species E.

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CONTRIBUTION TOWARDS A REVISION OF THE GENUS HYPOXYLON S.STR. (XYLARIACEAE, ASCOMYCETES) FROM PAPUA NEW GUINEA.

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Abstract

In this study of *Hypoxylon* Bull. s. str. in the rain forests of Papua New Guinea *Hypoxylon archeri, H. crocopeplum, H. bovei* var. *microsporum, H. dieckmannii, H. haematostroma, H. hypomiltum, H.* cf. *investiens, H. macroannulatum, H. nectrioideum, H. oodes, H. rubiginosum, H. sclerophaeum, H. stygium, H. subannulatum, H. subgilvum* and *H. truncatum* are described for the first time for the Papua New Guinean flora. *Hypoxylon retpela* sp. nov. is proposed. Special attention is given to spore ornamentation : the ascospores of *H. haematostroma, H. oodes* and *H. rubiginosum* are provided with transversely oriented fibrils, those of *H. crocopeplum, H. hypomiltum, H. retpela, H. subgilvum* and *H. investiens* are ornamented with transversely oriented ribs. A key to the species is provided.

Introduction

This paper describes some *Hypoxylon* species collected in the rain forests of Papua New Guinea.

Papua New Guinea forms part of one of the largest tropical islands of the world, together with Irian Jaya. It comprises an area of about 460000 km^2 situated between the latitudes 1° - 12° S and longitudes 141° - 160° E. The mainland is characterized by a central cordillera with peaks up to 4600 m and with intramontane valleys at about 1500 - 1800 m. It lies within the heavy precipitation belt of the humid tropics, most of the country receives over 2000 mm rainfall a year with recordings up to 4000 mm a year. Generally the wet season comes from December to March, with a drier season from May to October. However, it usually rains on both sides of the main cordillera throughout much of the year which makes it one of the largest constantly wet areas of the world. The lowland

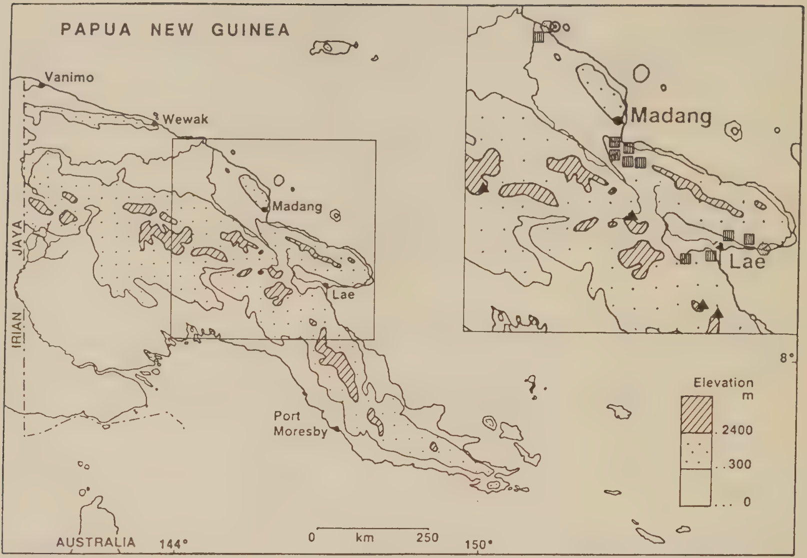


Fig. 1 : Map of the mainland of Papua New Guinea, with collecting spots of the 1989 expedition (see inset) (map modified from Shaw, 1984) : ▥ lowland rain forest (< 1000 m alt.) ; ▲ highland rain forest ; ⬡ mangroves ; ⊙ Laing Island (coralligeneous).

rain forest is the most common vegetation type, found up to about 1000 m altitude.

In 1989 we participated in an expedition, supported by the Belgian National Fund for Scientific Research (N.F.W.O.). During this expedition we explored the N.E. side of Papua New Guinea (see fig. 1), where we visited the following habitats : lowland rain forest, mountain rain forest, mangroves and Laing Island, a small coralligeneous Island.
Most collections were made in the lowland rain forests, and a few up to about 2800 m altitude.

Taxonomical delimitation

We recognize *Hypoxylon* Bull. s. str. to include only species with ectostromal pigmentation, spores with a germ slit on the dorsal side (the more convex side of the spore) and a loosening perispore (Pouzar 1979, 1985a, 1985b, 1986). These species constitute the sections *Hypoxylon, Annulata* and *Papillata* subsection *Papillata* as given by Miller (1961). Miller's sections *Applanata* and *Papillata* subsection *Primo-cinerea* are not treated here.

History

Citations of *Hypoxylon* species from Papua New Guinea are very scanty.
The first records of xylariaceous fungi for P.N.G. were noted by Cooke (1886), Cooke & Hennings (1889), Rehm (1889), Hennings (1892, 1893, 1894, 1898a, 1898b, 1899, 1900, 1901, 1905) and Massee (1898). Several *Xylaria* species were mentioned, one *Daldinia*, one *Kretzschmaria*, but no *Hypoxylon*.
The first record of a *Hypoxylon* was apparently made by Cunningham (1952 : 279) in his revision on the Australian and New Zealand species of Thelephoraceae and Hydnaceae of the Kew collection. He stated that collection number Bauerlen 10, Strickland River, New Guinea in the Kew Herbarium filed under *Corticium caeruleum* Fr. by Cooke was a sterile stroma of a *Hypoxylon sp.*
A second record was made by Doi (1971 : 396) who found a *Hypocrea atrogelatinosa* Dingley on "something that looks like a *Hypoxylon sp.*?". This specimen was collected in Rabaul.
Finally, there are records of *Hypoxylon deustum* (Hoffm. : Fr.) Greville, a synonym of *Ustulina deusta* (Hoffm. : Fr.) Lind., not belonging to the genus *Hypoxylon* s. str. It was recorded by Dumbleton (1954), Dwyer (1940) and Mann (1953) (not seen, cit. in Shaw 1984). Shaw (1984) mentioned that it was found on three different substrates : once on *Camellia sinensis* (L.) Kuntze (Theaceae), once on a *Citrus sp.* (Rutaceae) and 3 times on *Hevea brasiliensis* Muell. Arg. (Euphorbiaceae).
Since the first two records of *Hypoxylon* could not be identified more exactly, because of the poor condition of the collected material, and since the third record is an *Ustulina*, we can conclude that so far there is not a single published record of the genus *Hypoxylon* s.str. from P.N.G.

Materials and Methods

Most of the material studied was collected during an expedition to P.N.G. in 1989. Other material was received on loan from the Herbarium of the State University Liège (LG).
Most of our material could be compared with specimens from L, BR, K and specimens from the personal collection of A.J.S. Whalley (cited here as AJSW). The specimens from L have been annotated by J.H. Miller, and those from BR by R.W.G. Dennis.
The specimens were analyzed based on observations with bright field and S.E.Microscopy.
Reagents used with bright field microscopy were Melzer, KOH (10 %) and aqua destillata. Drawings were made with the aid of a camera lucida.
The colour of the stroma was checked by using an acetone extract. Colours are indicated using the Methuen Handbook of Colours by Kornerup & Wanscher (1978).
For the analyses with the S.E.M., material was stuck on tape affixed to an aluminum stub, vacuum coated with gold and examined. The ascospores were air-dried first.

The cited collections have been deposited in the herbarium GENT.

Results

I. Section *Hypoxylon*

Hypoxylon crocopeplum Berk. & Curt., Grevillea 4 : 49 (1875).

Descriptions and illustrations : Miller 1961 : 37-38, figs. 27, 53 ; Martin 1969 : 188-189, pl. II: 13, 14 ; Rogers et al. 1987 : 119.

This specimen corresponds to the descriptions given by Miller (1961), Martin (1969) and Rogers et al. (1987) except for the spore ornamentation which was not mentioned in the previous accounts. The ascospores are inaequilaterally ellipsoid with a straight germ slit running full length on the convex side of the spore (see fig. 2). They are characterized by a conspicuous dehiscent hyaline perispore (see also Rogers et al. 1987 : 119). By light microscopy these perispores appear to be indistinctly transversely striate, especially when examined in KOH (10%), since KOH loosens the perispore. When examined by S.E.M. they seem to be adorned with parallel to anastomosing rope-shaped ornaments, transversely oriented (see fig. 2 & pl. I a).

Specimen examined : PAPUA NEW GUINEA : MADANG PROVINCE : road Madang - Bogia, Nobanob, secondary forest, on dead wood, 6.9.1990, Van der Veken P. 90-674 (GENT).

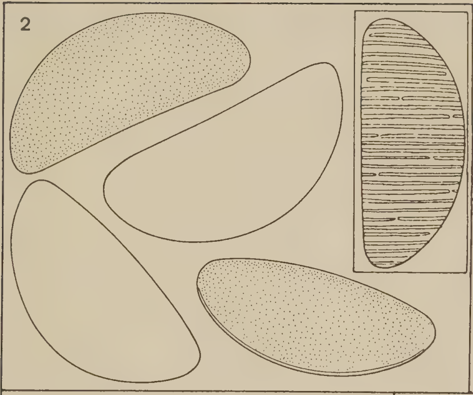
Reference material examined : UGANDA : Mpanga Forest, on dead wood, Taligoola H.K. 570, determinavit Whalley (AJSW).

Hypoxylon dieckmannii Theiss., Ann. Mycol. 6 : 346 (1908).

Descriptions and illustrations : Miller 1961 : 33, figs. 19, 48 ; Martin 1969 : 170-172, pl. I: 3.

We prefer to consider *H. dieckmannii* as a distinct species (Martin 1969) rather than a small spored variety of *H. rubiginosum* (Miller 1961), this on account of the ascospore characteristics and the pigmentation of the stroma which is very striking violet brown (K. & W. PL. 10F4) at maturity (see table 1, fig. 3 & pl. I b-c).

Figs. 2-7 & 9 : ascospores of members of the section *Hypoxylon* : 2. *H. crocopeplum* (Van der Veken P. 90-674) (inset : perispore ornamented with faint transverse striations) ; 3. *H. dieckmannii* (Van der Gucht K. 89-931) ; 4. *H. haematostroma* (Van der Gucht K. 89-1053a) ; 5. *H. hypomiltum* (Van der Gucht K. 89-1033) (inset : perispore ornamented with faint transverse striations) ; 6. *H. nectrioideum* (Van der Gucht K. & De Meester L. 89-1662) ; 7. *H. oodes* (Van der Gucht K. 89-525) ; 9. *H. rubiginosum* (Van der Gucht K. 89-604a)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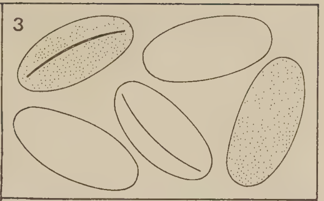
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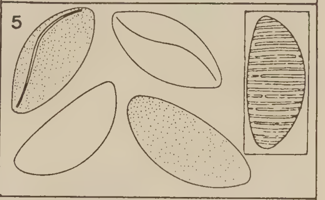
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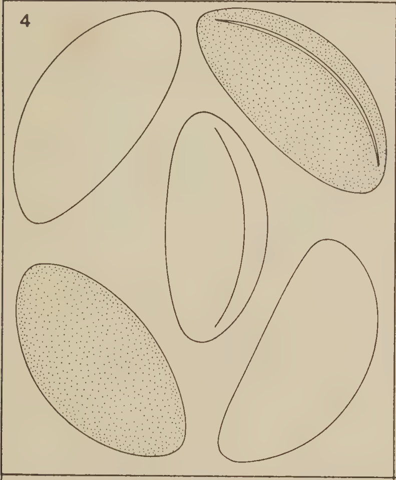
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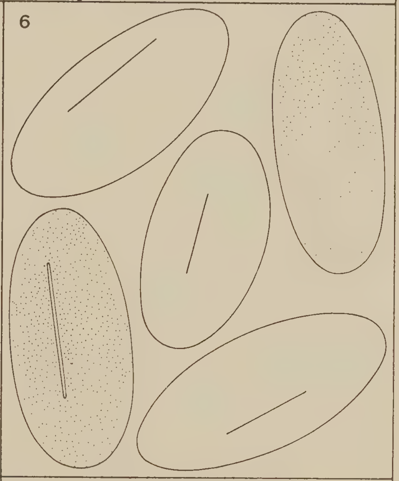
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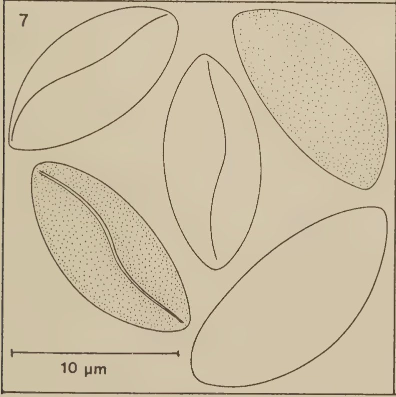
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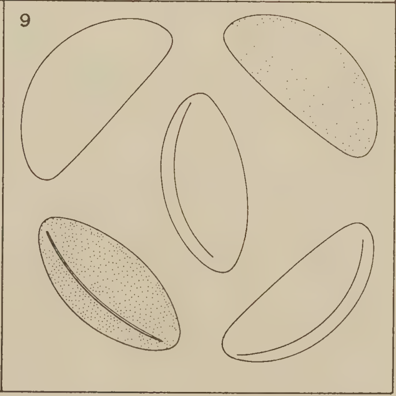
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Table 1 : comparison of the ascospore characteristics of *Hypoxylon rubiginosum* and *H. dieckmannii.*

	H. dieckmannii	*H. rubiginosum*
shape	equilaterally ellipsoid to ovoid	inaequilaterally ellipsoid
perispore	smooth	ornamented with transversely oriented fibrils (only seen by S.E.M.)

Specimens examined : PAPUA NEW GUINEA : MADANG PROVINCE : Hansa Bay, Laing Island, 4°10'S & 144°52'E, sea level, on dead decorticatd wood of *Planchonella obovata* (R.Br.) Pierre (Sapotaceae), 3.10.1989, Van der Gucht K. 89-514 (GENT). Eo loco, 19.8.1990, Van der Veken P. 90-240 (GENT). Bunapas, 4°11'S & 144°47'E, sea level, on dead wood, 20.10.1989, Van der Gucht K. 89-931 (GENT). Jogari, W-side of Manam, 4°05'S & 144°59'E, sea level, on dead decorticated wood, 31.1.1980, Demoulin V. & Smeets L. 5851 (LG, GENT). Alexishafen, bridge River Biges, 1 km to the left (W), on dead decorticated wood, 2.9.1990, Van der Veken P. 90-584 (GENT).

Reference material examined : INDIA : Uttar Pradesh, Asazori, on dead angiospermic stump, 29.8.1973, Dargan J.S. 13153, determinavit Dargan (K).

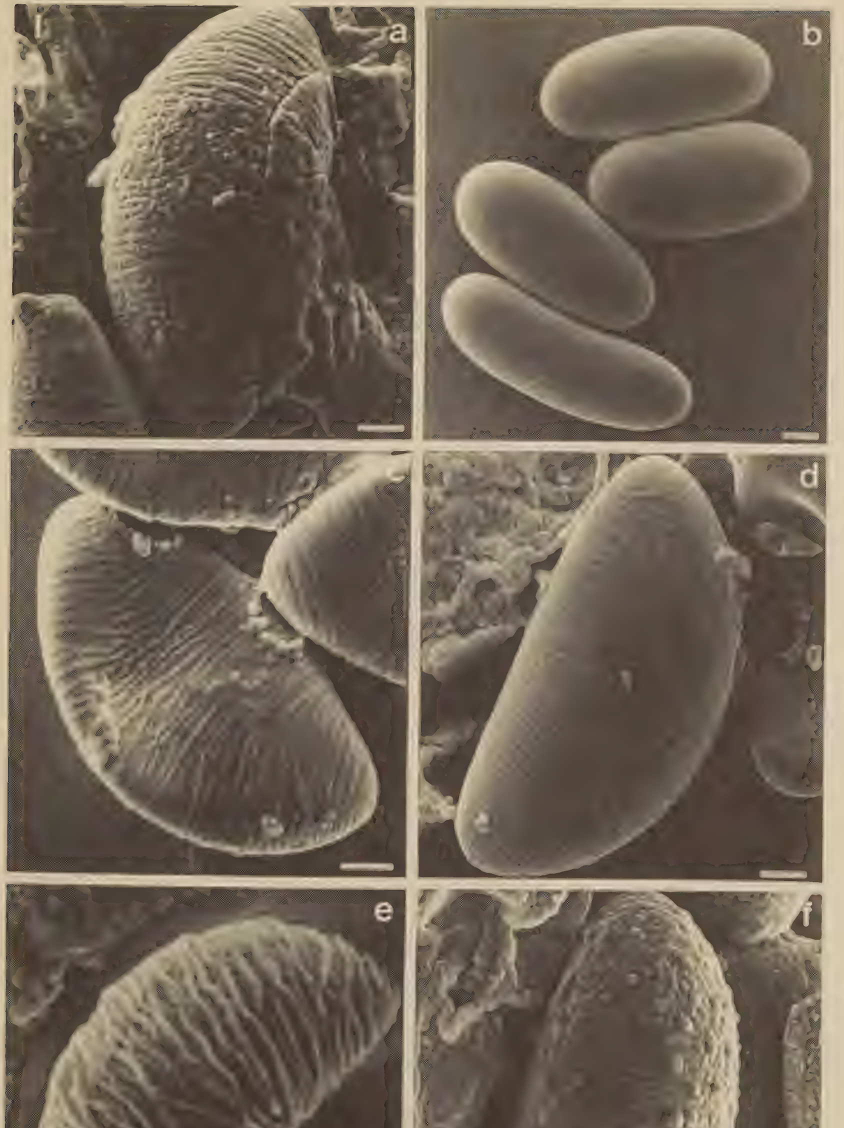
Hypoxylon haematostroma Mont. apud Ramon de la Sagra, Fl. Cubana I : 344 (1842).

Descriptions and illustrations : Miller 1961 : 36-37, figs. 24-26, 52 ; Dennis 1963 : 325, fig. 17D ; Martin 1969 : 195-196.

The ascospores of our specimen are smaller than those given by Miller (1961) and Dennis (1963) and than those measured in the type material : 13-14 x 5.5-8 µm vs 14-18 x 7-9 µm. The dimensions correspond however with those given by Martin (1969) : 10-16.5 x 5-9 µm (avg. 13.4 x 6.8 µm), as well as with those measured in the reference material (Vanderyst s.n. 1908) : 13.5-15.5 x 6-7.5 µm. The ascospores are ellipsoid - inaequilateral with rounded ends and a straight germ slit running on the most convex side of the spore over the whole length (see fig. 4). They appear to be smooth when examined by light microscopy. However when examined by S.E.M. the perispore seems to be ornamented with faint striations oriented perpendicular to the long axis of the spore (see fig. 4 & pl. I d).

Specimen examined : PAPUA NEW GUINEA : MOROBE PROVINCE : Lae, 6°43'S & 146°53'E, elev. 150 m, on dead wood, 24.10.1989, Van der Gucht K. 89-1053a (GENT).

Plate I : S.E.M. photographs of ascospores (scale bar = 1 µm) : a. *Hypoxylon crocopeplum* (Van der Veken P. 90-674) ; b. *H. dieckmannii* (Van der Gucht K. 89-931) ; c. *H. rubiginosum* (Van der Gucht K. 89-604a) ; d. *H. haematostroma* (Van der Gucht K. 89-1053a) ; e. *H. hypomiltum* (Van der Gucht K. & De Meester L. 89-2012a) ; f. *H. oodes* (Van der Gucht K. 89-510)


a
b
d
e
f

Reference material examined : CUBA : ex Montagne Herb. (TYPE, K).
ZAIRE : District du Bas-Congo, Sanda, 04°41'S & 15°26'E, on dead wood, 1908, Vanderyst H. s.n., determinavit Dennis (BR).

Hypoxylon hypomiltum Mont., Ann. Sci. Nat. Bot. sér. 2. 13 : 356 (1840). (non sensu J. H. Miller, 1961)

Descriptions and illustrations : Miller 1961 : 39-40, figs. 29, 55 ; Martin 1969 : 196-198 ; Abe 1986.

Our specimens correspond with the description of *H. jecorinum as* given by Miller (1961) and Martin (1969), and with the description of *H. hypomiltum* var. *hypomiltum* (non sensu J.H. Miller, 1961) as given by Abe (1986), but the ascospore ornamentation was not mentioned in these accounts.
Abe (1986), after examining the type specimens, placed *H. jecorinum* into synonymy with *H. hypomiltum* (non sensu J.H. Miller, 1961), a synonymy on which we can agree after examining the type material of *H. hypomiltum* and *H. jecorinum*. The ascospores are navicular to inaequilaterally ellipsoid, 7-9 (11) x 3.5-4.5 (5) µm, with a sigmoid germ slit, full length on the convex side of the spore (see fig. 5). They are characterized by a conspicuous dehiscent hyaline perispore (see also Rogers et al. 1987), which appear to be indistinctly transversely striate by light microscopy. When examined by S.E.M. they seem to be adorned with parallel to anastomosing rope-shaped ornaments, transversely oriented (see fig. 5 & pl. I e).

Specimens examined : PAPUA NEW GUINEA : MOROBE PROVINCE : Lae, 6°36'S & 147°02'E, elev. 300 m, on dead wood, 23.10.1989, Van der Gucht K. 89-1033 (GENT).
MADANG PROVINCE : South Naru, elev. 200 m, on dead wood, 13.11.1989, Van der Gucht K. & De Meester L. 89-2012a (GENT).

Reference material examined : FRENCH GUYANA : Cayenne, Leprieur 371 (HOLOTYPE of *H. hypomiltum*, K).
AMER. BOR. : Ex herb. Berk., on fallen limbs of *Platanus*, 1828 (SYNTYPE of *H. jecorinum*, K).
BRAZIL : Rio Grande do Sul, S. Leopoldo, on dead wood, Theissen, Decades Fungorum Brasiliensium exs. 74, determinavit Miller (L).

Hypoxylon nectrioideum Sacc. & Trott., Bull. Soc. Roy. Bot. Belgique 28 : 160 (1899).

Description and illustration : Dennis 1963 : 322, fig. 17B.

This specimen corresponds completely to the description given by Dennis (1963). The ascospores are oval to equilaterally ellipsoid with rounded ends, smooth, with a straight short germ slit (see fig. 6).

Specimen examined : PAPUA NEW GUINEA : MOROBE PROVINCE : Lae, 6°42'S & 146°51'E, sea level, on dead wood, 8.11.1989, Van der Gucht K. & De Meester L. 89-1662 (GENT).

Reference material examined : ZAIRE : locality unknown, Dewèvre A. s.n., (HOLOTYPUS, BR).

Hypoxylon oodes Berk. & Br., J. Linn. Soc., Bot. 14 : 122 (1873).

Descriptions and illustrations : Miller 1961 : 21, figs. 8, 39 ; Dennis 1963 : 320, fig. 17A ; Martin 1969 : 155-158, pl. I: 10-11.

Our material corresponds completely with the descriptions given by Miller (1961), Dennis (1963) and Martin (1969), but the ascospore ornamentation was not mentioned. The ascospores are inaequilaterally ellipsoid to navicular with a sigmoid germ slit on the convex side of the spore (see fig. 7). They are ornamented with faint transverse striations only seen by S.E.M. (see pl. I f).

Specimens examined : PAPUA NEW GUINEA : MADANG PROVINCE : Laing Island, 4°10'S & 144°52'E, sea level, on dead wood of *Diospyros maritima* Bl. (Ebenaceae), 3.10.1989, Van der Gucht K. 89-510 (GENT). Eo loco, on dead wood, 4.10.1989, Van der Gucht K. 89-525 (GENT). Eo loco, on dead wood of *Excoecaria agallocha* L. (Euphorbiaceae), 4.10.1989 & 6.10.1989, Van der Gucht K. 89-545a & 89-579a (GENT). Eo loco, on dead wood, 6.10.1989, Van der Gucht K. 89-584a (GENT). Eo loco, on dead wood, 17.11.1989, Van der Gucht K. 89-2034 & 89-2039 (GENT). MOROBE PROVINCE : Lae, 6°42'S & 146°51'E, sea level, on dead wood, 8.11.1989, Van der Gucht K. & De Meester L. 89-1661 (GENT). Lae, 6°36'S & 147°02'E, elev. 200 m, on dead wood, 9.11.1989, Van der Gucht K. & De Meester L. 89-1671a (GENT).

Reference material examined : ZAIRE : District du Bas-Congo, Kisantu, 05°08'S & 15°06'E, on decorticated wood, 31.01.1907, Vanderyst H. s.n., determinavit Dennis (BR).

Hypoxylon retpela[1] K. Van der Gucht & P. Van der Veken, sp. nov.

Stromata superficialia, applanata, 2 x 3 cm x 0.6 mm metientes, superficie cinereo-rosea vel rubiginosa (K. & W. PL. 9 D4), proxime sub superficie et circum partes peritheciorum superiores aurantiaca vel lateritia. Perithecia semiglobosa vel e compressione angularia, 0.25-0.4 mm diametro, emersa vel immersa. Ostiola umbilicata. Asci octospori, cylindrici, 105-130 µm longitudine tota x 6.5-8 µm crassi, partibus sporiferis 80-90 µm longitudine, annulo apicali in liquore iodata Melzeri immerso cyanescenti placentiformi 1 µm alto x 2.5 µm crasso. Paraphyses filiformes, 3 µm diametro, septatae. Ascosporae uni-seriatae inaequilateraliter ellipsoideae, obscure brunneae, 9-12 x 4-5.5 µm (plus minusve 9.8 x 4.7 µm). Rima germinativa recta per totam longitudinem sporae in latere convexo. Perispora conspicua hyalina dehiscens. Sub microscopio luminoso observata superficie laevis vel indistincte transverse striata, sub microscopio electrinoco scrutante simulacrum dantes ornamentorum parallelorum vel anastomosantium funiculiformium in spora transverse positorum.

Stromata superficial, applanate, 2 x 3 cm and 0.6 mm high. Surface greyish rose to reddish brown (K. & W. PL. 9 D4), with orange, brick red particles just beneath the surface and between the perithecial vertices. Acetone extract of the stroma reddish orange. **Perithecia** clearly evident to immersed, globose to compressed, 0.25-0.4 mm diam. **Ostiola** umbilicate. **Asci** 8-spored, cylindrical , 105-130 x 6.5-8 µm (the spore bearing part 70-80 µm), apical ring discoid, 1 µm high x 2.5 µm broad, blueing in Melzer's iodine reagent (see fig. 8a). **Paraphyses** filiform, 3 µm diam., septate. **Ascospores** uniseriate, inaequilaterally ellipsoid, dark brown, 9-12 x 4-5.5 µm (avg. 9.84 x 4.71 µm). Germ slit straight, full length, on the convex side of the spore (see fig. 8b). Perispore conspicuous, dehiscent, hyaline, appearing smooth or indistinctly transversely striate by light microscopy, seems to be adorned with parallel to anastomosing rope-shaped ornaments oriented perpendicular to the long axis of the spore by scanning electron microscopy (see fig. 8b & pl. II a).

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[1] pidgin for pink and red

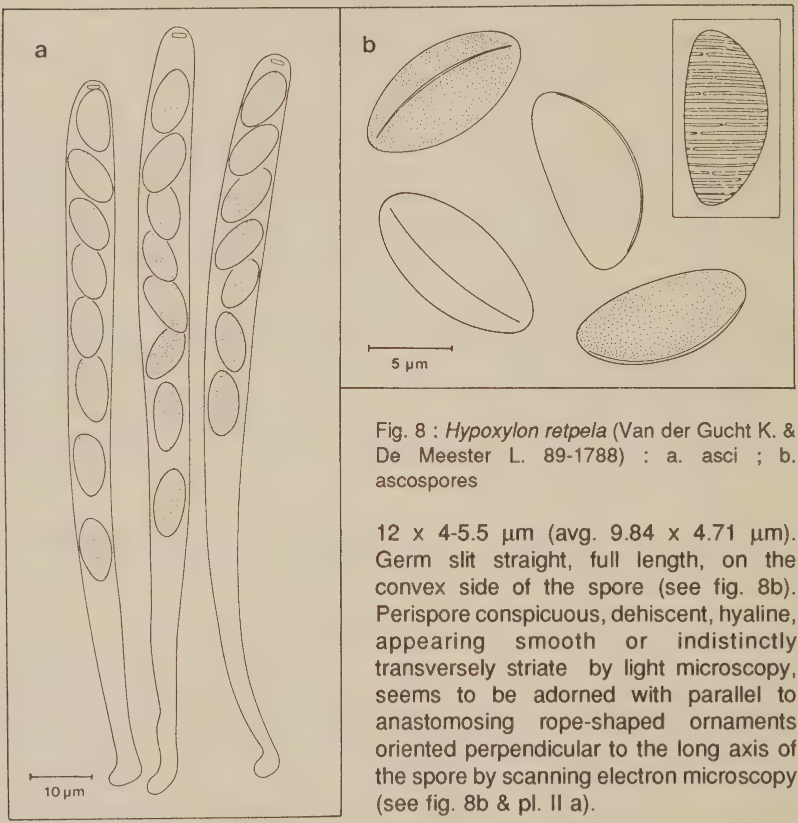

Fig. 8 : *Hypoxylon retpela* (Van der Gucht K. & De Meester L. 89-1788) : a. asci ; b. ascospores

Hypoxylon retpela seems closely related to *H. crocopeplum, H. duranii* (Rogers 1985), *H. gillesii* (Rogers & Candousseau 1982), *H. hypomiltum* and *H. subgilvum*, the only described species with ascospores conspicuously ornamented with transversely oriented ribs.

It is distinguished by its greyish rose to reddish brown stromatal coloration instead of the typical orange brown to rusty red coloration as is found in the other species.

Specimen examined : PAPUA NEW GUINEA : MADANG PROVINCE, Balek Wildlife Sanctuary, elev. 150 m, on dead wood, 11.11.1989, Van der Gucht K. & De Meester L. 89-1788 (HOLOTYPE, GENT ; ISOTYPE, K).

Hypoxylon rubiginosum (Pers.:Fr.) Fr., Summa Veg. Scand. : 384 (1849).

Descriptions and illustrations : Miller 1961 : 26-31, figs. 13-15, 45 ; Dennis 1963 : 322-325 ; Martin 1969 : 172-175, pl.I: 3 & pl.II: 1-4 ; Rogers 1969 ; Petrini & Müller 1986 : 529-534, abb. 12-14.

Our material corresponds well with the descriptions given by Miller (1961), Dennis (1963), Martin (1969) and Rogers (1969). Petrini & Müller (1986) recognized three different varieties of *H. rubiginosum* based on European material. Our material corresponds to *H. rubiginosum* var. *perforatum* characterized by the short stipes of the ascus : 25-40 µm (total size of the ascus : 95-105 x 6-8 µm). This variety is also known from Brazil (Petrini & Müller 1986).
The ascospores are inaequilaterally ellipsoid, 9.5-11 (12.5) x 4-5.5 µm, with a straight germ slit full length on the convex side of the spore (see fig. 9). The perispore is ornamented with transversely oriented fibrils, only visible by S.E.M. (pl. I c).

Specimens examined : PAPUA NEW GUINEA : EASTERN HIGHLANDS PROVINCE : Ukarumpa, 6°20'S & 146°53'E, elev. 1700 m, on dead wood, 8.10.1989, Van der Gucht K. 89-604a (GENT). MOROBE PROVINCE : Wau, Biaru Raod, 7°30'S & 146°48'E, elev. 1650 m, on dead wood, 5.11.1989, Van der Gucht K. & De Meester L. 89-1549 (GENT).

Hypoxylon sp., a member of the rubiginosum complex.

This fungus differs from typical *H. rubiginosum* as described by Miller (1961) in having brick red granules just beneath the stromatal surface and between the perithecial vertices. The perithecia, asci and ascospores are smaller (see table 2 & fig. 10). The ornamentation of the perispore is less conspicuous than for the typical *H. rubiginosum.*

Table 2 : comparison of *H. rubiginosum* with *H. sp.*, a member of the rubiginosum complex.

	H. rubiginosum	*H. sp.*
perithecia (mm)	0.2-0.3	0.1-0.2
asci (µm)	95-105 x 5-8 (sp.p. 65-75)	60-75 x 6 (sp.p. 50-55)
ascospores (µm)	9.5-12.5 x 4-5.5 (avg. 10.5 x 4.8)	7.8-9 x 3.5-4.5 (avg. 8.4 x 3.9)

Rogers et al. (1987) collected a similar specimen from the rain forests of North Sulawesi. Our material differs from their description primarily in having smaller ascospores 7.8-9 x 3.5-4.5 vs (10)11-12 x 4.5-6 µm. The present material was probably somewhat immature.

Specimen examined : PAPUA NEW GUINEA : SOUTHERN HIGHLANDS PROVINCE : Kaupena, 6°10'S & 144°01'E, elev. 2280 m, on dead branch of *Bambusa sp.*, 11.10.1989, Van der Gucht K. 89-735 (GENT).

Hypoxylon sclerophaeum Berk. & Curt., Exot. Fungi Schw., J. Acad. Nat. Sci. Philadelphia ser. 2 : 285 (1853).

Descriptions and illustrations : Miller 1961 : 40-41, figs. 30, 56 ; Dennis 1963 : 326, fig. 17F ; Martin 1969 : 202, pl.I: 13.

Our specimens correspond completely with the descriptions given by Miller (1961), Dennis (1963) and Martin (1969). The ascospores are inaequilaterally ellipsoid, smooth, with a straight germ slit full length on the convex side of the spore (see fig. 11).

Specimens examined : PAPUA NEW GUINEA : MADANG PROVINCE : Laing Island, 4°10'S & 144°52'E, sea level, on dead wood, 4.10.1989 & 6.10.1989, Van der Gucht K. 89-526 & 89-576 (GENT).

Hypoxylon subgilvum Berk. & Br., J. Linn. Soc., Bot. 14 : 120 (1873).

Descriptions and illustrations : Miller 1961 : 38-39, figs. 28, 54 ; Dennis 1963 : 326, fig. 17E ; Martin 1969 : 193, pl.II: 15.

This material corresponds completely with the description of *Hypoxylon hypomiltum* (non sensu Abe, 1986) as given by Miller (1961), Dennis (1963) and Martin (1969), and with the morphological data of *H. subgilvum* given by Abe (1986), with the exception that ascospore ornamentation, existing of transversally oriented ribs, was not mentioned.

The ascospores of *H. subgilvum* are inaequilaterally ellipsoid with a straight germ slit running full length on the convex side of the spore (see fig. 12). The germ slit

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Figs. 10-12 : ascospores of the section *Hypoxylon* : 10. *Hypoxylon sp.*, a member of the rubiginosum complex (Van der Gucht K. 89-735) ; 11. *H. sclerophaeum* (Van der Gucht K. 89-526) ; 12. *H. subgilvum* (Demoulin V. 6902) (inset : perispore ornamented with faint transverse striations) ; section *Papillata* subsection *Papillata* : 13. *H. investiens* (Van der Gucht K. & De Meester L. 89-1646) (inset : perispore ornamented with faint transverse striations) ; section *Annulata* : 14. *H. archeri* (Van der Gucht K. & De Meester L. 89-1722) ; 15. *H. bovei* var. *microsporum* (Van der Gucht K. 89-818) ; 17. *H. stygium* (Van der Gucht K. & De Meester L. 89-1656) ; 19. *H. truncatum* (Van der Gucht K. & De Meester L. 89-1686)

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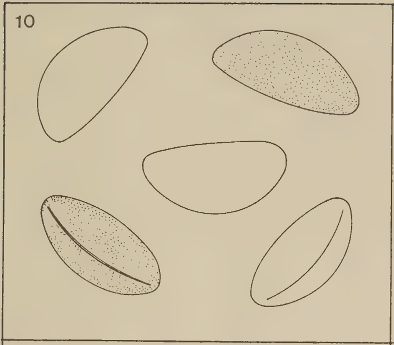

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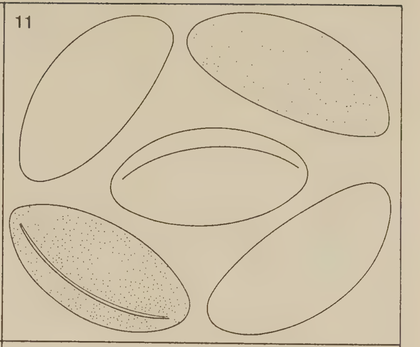

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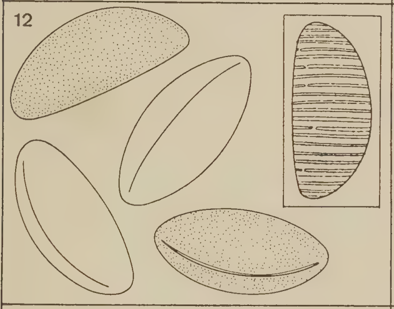

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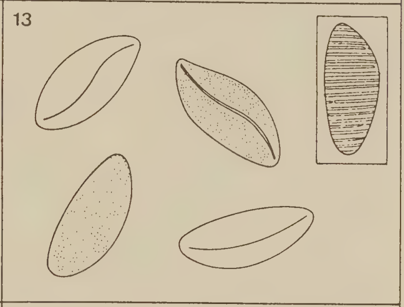

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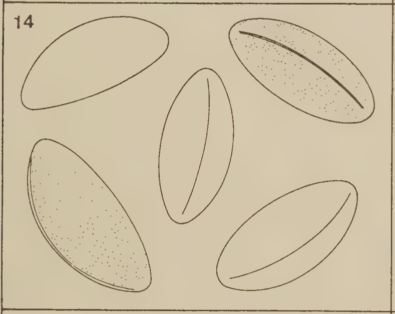

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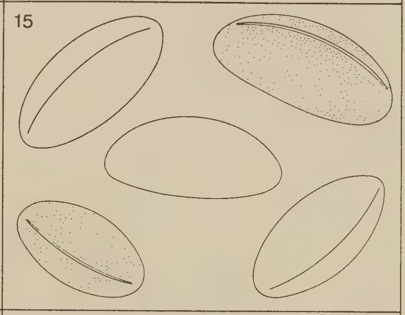

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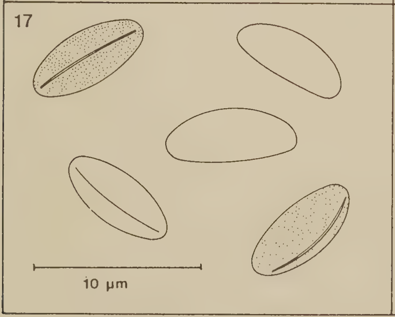

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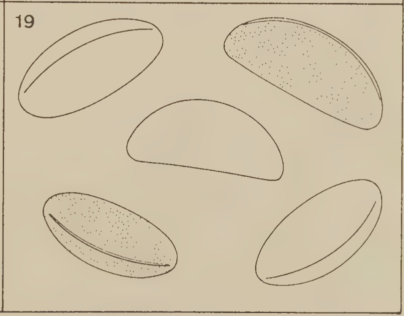

is not always evident. They are characterized by a conspicuous dehiscent hyaline perispore which appears to be indistinctly transversely striate by light microscopy, just like the ascospores of *H. crocopeplum, H. hypomiltum* and *H. retpela.* Examining the spores by S.E.M. we found a similar ornamentation exhibited by those species, existing of parallel to anastomosing rope shaped ornaments, oriented perpendicular to the long axis of the spore (see pl. II b).

A very similar ornamentation of ascospores has already been found within the species *H. gillessii* (Rogers & Candousseau 1982) and *H. duranii* (Rogers 1985), the only other species described with ascospores conspicuously ornamented with transversely oriented ribs.
All these species, *H. crocopeplum, H. subgilvum, H. hypomiltum, H. gillessii* and *H. duranii* are similar in the rusty red color of mature stromata and the umbilicate ostioles. They differ in the size of their ascospores and in the habit of their stromata.

Specimen examined : PAPUA NEW GUINEA : MADANG PROVINCE : Laing Island, sea level, 4°10'S & 144°52'E, on dead wood, 18.4.1986, Demoulin V. 6902 (LG, GENT).

Reference material examined : CEYLON : Dec. 1868, Twaite L.H.K. 1087 (HOLOTYPE, K). ZAIRE : District du Bas-Congo, Kisantu, 05°08'S & 15°06'E, on dead wood, 1907, Vanderyst H. s.n., determinavit Dennis (BR).

II. Section *Papillata* subsection *Papillata*

Hypoxylon* cf. *investiens (Schw.) Curt., Geol. & Nat. Hist. Survey, 3 : 140 (1867).

Descriptions and illustrations : Miller 1961 : 49-52, figs. 65-66, 81 ; Dennis 1963 : 327, fig. 17G ; Martin 1968 : 307.

This fungus looked much like *H. investiens* as described by Miller (1961) and Dennis (1963) but differs in having smaller ascospores i.e. 8-11 x 3.5-5 µm vs 7-9.5 x 3-4 µm. Martin (1968) gives a wide range of spore size i.e. 3-7.5 x 6-18 µm but the average he mentioned is again larger than the average we find cfr. 10.3 x 4.7 µm vs 8.23 x 3.49 µm. Rogers et al. (1987) find the same phenomenon within the specimens they collected in the rain forests of North Sulawesi (Indonesia). The dimensions of the ascospores of their specimen (7-9.5 x 3-3.8 µm) fit completely our spore dimensions.
There is a strong possibility we have here a small spored variety of *Hypoxylon investiens* which can be found in the tropics. Small spored varieties have

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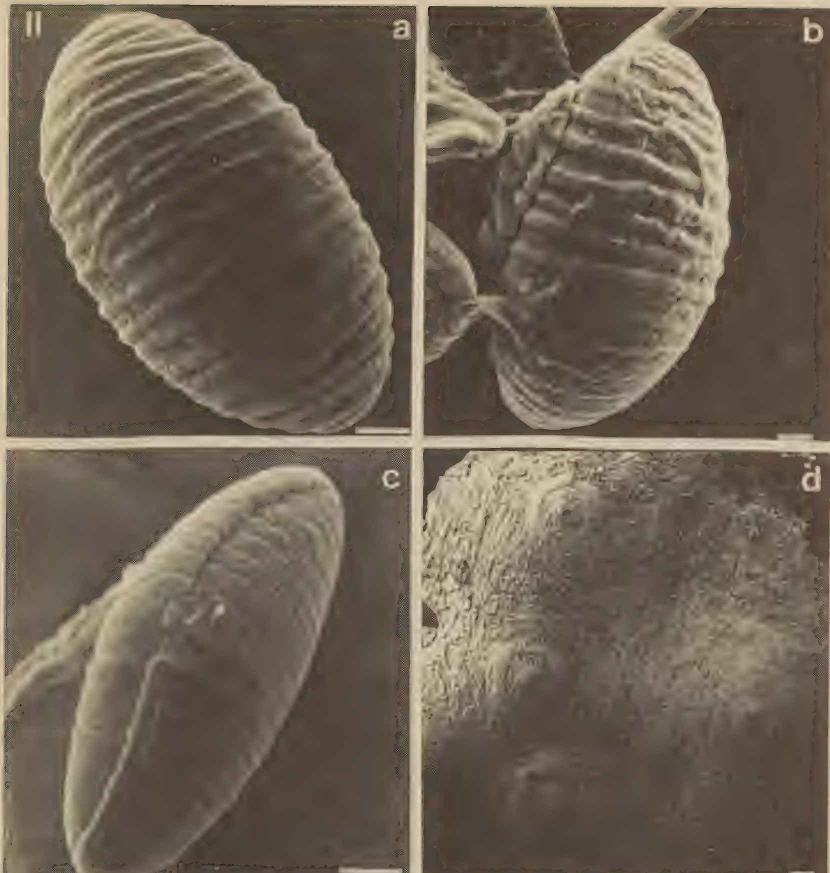
Plate II : S.E.M. photographs : a-b-c-e ascospores (scale bar = 1µm) : a. *Hypoxylon retpela* (Van der Gucht K. & De Meester L. 89-1788) ; b. *H. subgilvum* (Demoulin V. 6902) ; c. *H. investiens* (Van der Gucht K. 89-1051) ; e. *H. macroannulatum* (Van der Gucht K. 89-636a) ; d. stroma of *H. subannulatum* (Van der Gucht K. 89-1221) (scale bar = 100 µm) ; f. stroma of *H. macroannulatum* (Van der Gucht K. 89-636a) (scale bar = 1mm)


II
a
b
c
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e
f

repeatedly been observed within the genus *Hypoxylon* from different continents e.g. *Hypoxylon weldenii* (Rogers 1980), *Hypoxylon chestersii* (Rogers & Samuels 1985) and *Hypoxylon aeruginosum* (Rogers & Samuels 1985).

Another important characteristic is the spore ornamentation. The ascospores are navicular to inaequilaterally ellipsoid with a sigmoid germ slit full length on the convex side of the spore (see fig. 13). When examined superficially the mature ascospores appear to be smooth. However, faint transverse striations can be seen at high magnification, and can be made more conspicuous by making a slide in KOH (10%).

The true nature of the ascospore ornamentation becomes clear when examined by S.E.M. It is composed of subparallel ribs, transversely oriented (see pl. II c). The ascospore ornamentation of our specimens seems identical to the typical variety.

This is the first species within the section Papillata subsect. Papillata known to have ornamented ascospores.

The presence of more or less conspicuous transversely oriented perispore elements was already seen in some species of the section Hypoxylon (see *H. hypomiltum*, *H. subgilvum*, *H. rubiginosum* and *H. haematostroma*). This ornamentation of the ascospores might indicate a closer relationship of *H. investiens* with the section Hypoxylon.

Whalley and Whalley (1977) suggest that *H. investiens* and its allies form a transitional series between the sections Hypoxylon and Papillata subsect. Primocinerea, on account of the colour of the acetone extract of the stroma. They found that only one collection of *H. investiens* yielded pigment, the others remained colourless. We also found coloured as well as colourless extracts of our specimens.

Specimens examined : PAPUA NEW GUINEA : MADANG PROVINCE : Laing Island, 4°10'S & 144°52'E, sea level, on dead wood of *Diospyros maritima* Bl. (Ebenaceae), 3.10.1989, Van der Gucht K. 89-512a (GENT). Eo loco, on dead wood, 6.10.1989, Van der Gucht K. 89-589 (GENT). Bunapas, 4°12'S & 144°49'E, sea level, on dead wood, 30.10.1989, Van der Gucht K. & De Meester L. 89-1311 (GENT). Finisterre Range, 5°28'S & 145°29'E, elev. 500 m, on dead wood, 12.11.1989, Van der Gucht K. & De Meester L. 89-1873, 89-1900 (GENT). The end of the Finisterre Range, 5°45'S & 145°53'E, elev. 150 m, on dead wood, 3-11-1989, Van der Gucht K. & De Meester L. 89-1465 (GENT).

MOROBE PROVINCE : Lae, 6°43'S & 146°53'E, elev. 150 m, on dead wood, 24.10.1989, Van der Gucht K. 89-1051, 89-1056c (GENT). Wau Road, 6°52'S & 146°37'E, elev. 650 m, on dead wood, 8.11.1989, Van der Gucht K. & De Meester L. 89-1646a (GENT). Lae, 6°36'S & 147°02'E, elev. 200 m, on dead wood, 9.11.1989, Van der Gucht K. & De Meester L. 89-1671b (GENT).

Reference material examined : ZAIRE : District Forestier Central, Boende, 00°13'S & 20°52'E, on dead wood, 10-1926, Staner R. 1672, determinavit Dennis (BR).

III. Section *Annulata*

Hypoxylon archeri Berk., Fl. of Tasmania II, in Hook., Bot. Antarctic Voy. II : 280 (1860).

Descriptions and illustrations : Miller 1961 : 91, figs. 155-169 ; Dennis 1964 : 236.

Our material corresponds well with the descriptions given by Miller (1961) and Dennis (1964). The ascospores are inaequilaterally ellipsoid, smooth, with a straight germ slit running full length on the convex side of the spore (see fig. 14).

Specimens examined : PAPUA NEW GUINEA : MADANG PROVINCE : the end of the Finisterre Range, 5°45'S & 145°35'E, elev. 150 m, on dead wood, 3-11-1989, Van der Gucht K. & De Meester L. 89-1521 (GENT).

MOROBE PROVINCE : Lae, 6°43' S & 147°04'E, elev. sea level, on dead wood, 25-10-1989, Van der Gucht K. 89-1157 (GENT). Lae, 6°36'S 147°02'E, elev. 200 m, on dead wood, 9-11-1989, Van der Gucht K. & De Meester L. 89-1722 (GENT).

Reference material examined : ZAIRE : District Forestier Central, Yangambi, 00°46'S & 24°27'E, on *Scorodophloeus zenkeri* Harms, Fassi B. 774, determinavit Dennis (BR).

Hypoxylon bovei Speg. **var. *microsporum*** Mill., Monograph : 95 (1961).

Descriptions and illustrations : Miller 1961 : 95 ; Pérez-Silva 1983 : 11, figs. 16 & 17.

This fungus is very much like *H. bovei* var. *microsporum* as described by Miller (1961), differing in its somewhat larger ascospores i.e. 9-10.5 x 4-5 µm vs 8-10 x 3-4 µm.

Pérez-Silva (1983) mentioned an incomplete germ slit for the spores. We could however clearly observe a germ slit of full spore length (see fig. 15).

Specimen examined : PAPUA NEW GUINEA : EASTERN HIGHLANDS PROVINCE : Ukarumpa, 6°21'S & 145°56'E, elev. 1800-1850 m, on dead wood, 14.10.1989, Van der Gucht K. 89-818 (GENT).

Hypoxylon macroannulatum Ito & Imai, Trans. Sapporo Nat. Hist. Soc. 16 : 137 (1940).

Stromata globose to hemispheric, surface black, 1.5 - 3 cm diam. near the base and 0.8 - 1 cm high, superficial on bark (see fig. 16a). Endostroma dark brown, massive in development, carbonaceous to corky at the base, distinctly radiate - fibrous. Acetone extract of the stroma yellowish brown (K. & W. PL. 5 D5). **Perithecia** peripheral, globose to angular due to compression, 0.8 - 1 mm in diam.

Ostiola papillate each in the center of a slightly sunken, plane annular disc usually with a raised margin, 0.65 - 0.80 mm in diam. (avg. 0.7 mm diam.) (see fig. 16a & pl. II f). **Asci** and **paraphyses** not seen. **Ascospores** inaequilaterally ellipsoid with rounded ends, brown, 9.5-12.5 x 4.5-5.5 µm (avg. 11 x 5 µm). Germ slit straight, full length, on the convex side of the spore (see fig. 16b & pl. II e). Perispore smooth.

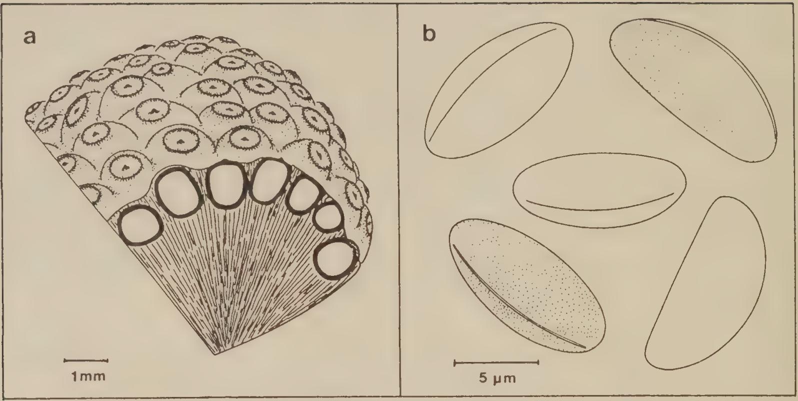

Fig. 16 : *Hypoxylon macroannulatum* (Van der Gucht K. 89-636a) : a. stroma ; b. ascospores

Hypoxylon macroannulatum was described by Ito & Imai (1940 : 137) on a collection from the Bonin Islands. Our material corresponds to their description very well. *H. macroannulatum* was up to now only known from the type locality.

Specimen examined : PAPUA NEW GUINEA : EASTERN HIGHLANDS PROVINCE : 6°22'S & 146°55'E, elev. 1750 m, on bark of unidentified wood, 9.10.1989, Van der Gucht K. 89-636a (GENT).

Hypoxylon stygium (Lév.) Sacc., Syll. Fung. 1 : 379 (1882).

Descriptions and illustrations : Miller 1961 : 91-93, figs. 156, 170 ; Dennis 1963 : 334-335, fig. 18C ; Martin 1968 : 322-328, pl. I: 7.

In the literature we find differences in the descriptions of *Hypoxylon stygium*. Table 4 gives the most important characteristics.

The most striking difference lies within the size of the perithecia i.e. small to minute according to Miller (1961) and Dennis (1963) and clearly larger according to Martin (1968).

Based on those descriptions our material of *H. stygium* could be divided in three groups of specimens. One that corresponds completely with the description given by Miller (1961) and Dennis (1963). Another that fits Martin's description (1968), and finally a third group of specimens that lies in between, which means that they show large perithecia and very small annular discs (< 0.2 mm) or vice versa.

The ascospores are inaequilaterally ellipsoid, smooth with a straight long germ slit, on the convex side of the spore (see fig. 17).

Table 4 : Comparison of the dimensions of the main characteristics of *H. stygium* according to three different authors and our material.

	Miller (1961)	Dennis (1963)	Martin (1968)	our material
Size of perithecia (mm)	100-300	→ 400	500-800 x 750-900	200-800
annular disc (mm)	0.1-0.2	→ 0.3	0.2-0.3	0.1-0.3
asci (μm)	sp.p. 40-60 x 3.5-4 (stipe 15-20)	-	54-170 x 3-5 (stipe 9-105)	60-105 x 3-4.5 (sp.p. 50-60)
ascospore dimensions (μm)	5-8 x 2.5-3	5-8 x 2.5-3	4.5-8.5 x 2-5	5-8 x 2.5-3.5

Specimens examined : PAPUA NEW GUINEA : MADANG PROVINCE : Laing Island, 4°10'S & 144°52'E, sea level, on dead decorticated wood, 4.10.1989, Van der Gucht K. 89-533 (GENT). Finisterre Range, 5°24'S & 145°38'E, elev. 200 m, on dead wood, 22.10.1989, Van der Gucht K. 89-953b (GENT). Finisterre Range, 5°45'S & 145°35'E, elev. 150 m, on dead wood, 3.11.1989, Van der Gucht K. & De Meester L. 89-1480 (GENT). Bunapas, 4°11'S & 144°47'E, sea level, on dead wood, 30.10.1989, Van der Gucht K. & De Meester L. 89-1360 (GENT). Balek Wildlife Sanctuary, 5°20'S & 145°43'E, elev. 150 m, on dead wood, 11.11.1989, Van der Gucht K. & De Meester L. 89-1818 (GENT). South Naru, elev. 200 m, on dead wood, 13.11.1989, Van der Gucht K. & De Meester L. 89-1996 (GENT).

MOROBE PROVINCE : Bulolo, Manki, on *Castanopsis acuminatissima*, 31.1.1973, Horak E. NG 178 (K). Lae, 6°43'S & 147°01'E, sea level, on dead wood, 15.10.1989, Van der Gucht K. 89-826, 89-827a (GENT). Lae, 6°36'S & 147°02'E, elev. 300 m, on dead wood, 23.10.1989, Van der Gucht K. 89-1031 (GENT). Lae, 6°43'S & 146°53'E, elev. 150 m, on dead wood, 24.10.1989, Van der Gucht K. 89-1049a (GENT). Lae, 6°42'S & 146°51'E, sea level, on dead wood, 8.11.1989, Van der Gucht K. & De Meester L. 89-1656, 89-1659 (GENT). Lae, 6°36'S & 147°02'E, elev. 200 m, on dead wood, 9.11.1989, Van der Gucht K. & De Meester L. 89-1667, 89-1669, 89-1720 (GENT).

EASTERN HIGHLANDS PROVINCE : Ukarumpa, 6°20'S & 146°53'E, elev. 1700 m, on dead wood, 8.10.1989, Van der Gucht K. 89-609 (GENT). Ukarumpa, 6°21'S & 145°56'E, elev. 1800 m, on dead wood, 14.10.1989, Van der Gucht K. 89-819 & 89-821b (GENT).

SOUTHERN HIGHLANDS PROVINCE : near lake Kutubu, 6°20'S & 143°17'E, elev. 910 m, on dead decorticated wood, 11.10.1988, Vyverman W. 339 (GENT).

Reference material examined : ZAIRE : District Forestier Central, Yangambi, 00°46'S & 24°27'E, on *Scorodophleus zenkeri* Harms., Fassi B. 764, determinavit Dennis (BR).

Hypoxylon subannulatum Henn. & Nym., Monsunia 1 : 168 (1899).

Description and illustration : Miller 1961 : 93-94, figs. 157, 171.

Our material corresponds to the description of *H. subannulatum* as given by Miller (1961), except for the ascospores which are somewhat smaller : 12-15 x 5.6-7 μm vs (9.5) 10-14 x (4) 4.5-6 μm.

Further characters, not mentioned by Miller (1961) are : asci with a rectangular (3-4 x 2.5 μm), amyloid apical plug (see fig. 18a); ascospores devoid of a

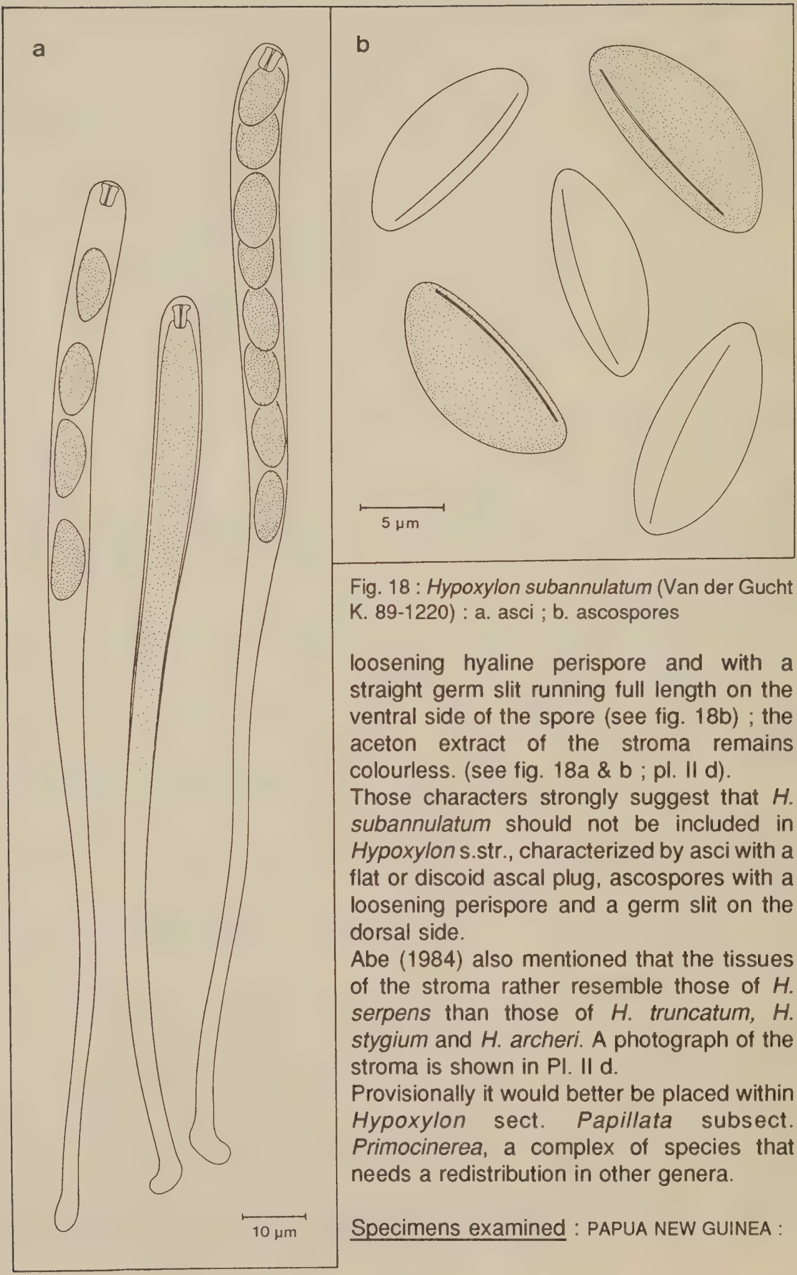

Fig. 18 : *Hypoxylon subannulatum* (Van der Gucht K. 89-1220) : a. asci ; b. ascospores

loosening hyaline perispore and with a straight germ slit running full length on the ventral side of the spore (see fig. 18b) ; the aceton extract of the stroma remains colourless. (see fig. 18a & b ; pl. II d).

Those characters strongly suggest that *H. subannulatum* should not be included in *Hypoxylon* s.str., characterized by asci with a flat or discoid ascal plug, ascospores with a loosening perispore and a germ slit on the dorsal side.

Abe (1984) also mentioned that the tissues of the stroma rather resemble those of *H. serpens* than those of *H. truncatum, H. stygium* and *H. archeri.* A photograph of the stroma is shown in Pl. II d.

Provisionally it would better be placed within *Hypoxylon* sect. *Papillata* subsect. *Primocinerea*, a complex of species that needs a redistribution in other genera.

Specimens examined : PAPUA NEW GUINEA :

MADANG PROVINCE : Finisterre Range, 5°27'S & 145°32'E, elev. 250 m, on dead wood, 27.10.1989, Van der Gucht K. 89-1220 & 89-1221 (GENT).

Reference material examined : PHILIPINES : Laguna Province, Mount Maquiling, near Los Banos, on rotting trunks, Baker C.F. 543, determinavit Abe 1986 & Laessoe 1991 (K)

Hypoxylon truncatum (Schw. ex Fr.) Mill., Trans. Brit. Myc. Soc. 17 : 130 (1932).

Descriptions and illustrations : Miller 1961 : 95-98, figs. 160-165, 173-174 ; Dennis 1963 : 335-336, fig. 18D ; Carroll 1964 : 303-304, figs. 6, 12-13 ; Martin 1968 : 317-322, pl. I: 3-6.

Our material corresponds with the descriptions given by Miller (1961), Dennis (1963), Carroll (1964) and Martin (1968). The ascospores are inaequilaterally ellipsoid, smooth, with a straight long germ slit running on the convex side of the spore (see fig. 19).

Specimens examined : PAPUA NEW GUINEA : MADANG PROVINCE : Laing Island, 4°10'S & 144°52'E, sea level, on dead wood, 4.10.1989, Van der Gucht K. 89-527 (GENT). Finisterre Range, 5°24'S & 145°38'E, elev. 200 m, on dead wood, 22.10.1989, Van der Gucht K. 89-953a, 89-971 (GENT). Finisterre Range, 5°27'S & 145°32'E, elev. 350 m, on dead wood, 27.10.1989, Van der Gucht K. 89-1270 (GENT). Bunapas, 4°11'S & 144°47'E, sea level, on dead wood, 30.10.1989, Van der Gucht K. & De Meester L. 89-1353 (GENT). Balek Wildlife Sanctuary, 5°20'S & 145°43'E, elev. 150 m, on dead wood, 11.11.1989, Van der Gucht K. & De Meester L. 89-1824 (GENT).

MOROBE PROVINCE : Bulolo, Manki, on *Castanopsis acuminatissima*, 31.1.1973, Horak E. NG 177 (K). Bulolo, Watut, on unidentified wood, 30.1.1973, Horak E. NG 176 (K). Lae, 6°36'S & 147°02'E, elev. 300 m, on dead wood, 23.10.1989, Van der Gucht K. 89-1026 (GENT). Lae, 6°43'S & 146°53'E, elev. 150 m, on dead wood, 24.10.1989, Van der Gucht K. 89-1102 (GENT). Lae, 6°36'S & 147°02'E, elev. 200 m, on dead wood, 9.11.1989, Van der Gucht K. & De Meester L. 89-1670, 89-1677 & 89-1686 (GENT).

EASTERN HIGHLANDS PROVINCE : N.E. of Kainantu, Kassem Pass, on rotten wood, 16.2.1973, Horak E. NG 185 (K).

SOUTHERN HIGHLANDS PROVINCE : Kaupena, 6°10'S & 144°01'E, elev. 2280 m, on dead wood, 11-10-1989, Van der Gucht K. 89-696 (GENT).

Reference material examined : ZAIRE : District du Bas-Congo, Kisantu, 05°08'S & 15°06'E, on dead wood, 12.1906, Vanderyst H. s.n., determinavit Dennis (BR).

Identification key

1a		Perithecial ostioles umbilicate or punctate (section *Hypoxylon*)	2
1b		Perithecial ostioles papillate	12
	2a	Stromata rosellinioid, the individual perithecia sometimes appearing to be completely free	3
	2b	Stromata large, plano-convex or stromata indefinitely effused with the perithecial contours usually not evident	4
3a		Surface greyish brown to purple grey (K. & W. pl.7E3) with black umbilicate	

or occasionally papillate ostioles ; ascospores inaequilaterally ellipsoid to navicular, 11-13 (15) x (4.5) 5-6 (6.5) µm, with a sigmoid germ slit, full length ***H. oodes***

3b Surface cinnamon to brownish orange (K. & W. pl.6C5) with umbilicate ostioles ; ascospores equilaterally ellipsoid to oval, 12.5-15.5 x 6-7 (7.5) µm, with a straight, short germ slit ***H. nectrioideum***

4a Stromata large, plano-convex, more than 5 mm thick, surface reddish brown to black with age ; ascospores brown, 10-13 (15) x 4.5-6 (6.5) µm ***H. sclerophaeum***

4b Stromata indefinitely effused, the individual perithecia embedded in the stroma 5

5a Stromata lacking bright coloured granules just beneath the surface, surface some shade of grey-brown, red or purple 6

5b Stromata with orange to brick red granules just beneath the surface ; ascospores with a conspicuous dehiscent perispore 7

6a Stromata purple red to greyish brown (K. & W. pl.9E4), often with white periphysate ostiolar mouths ; ascospores inaequilaterally ellipsoid, (9.5) 10-12 x 4-5.5 µm ***H. rubiginosum***

6b Stromata deep purple red (K. & W. pl.10F4), ostioles indistinct ; ascospores equilaterally ellipsoid with broad rounded ends, 7-9 x 3-4 µm ***H. dieckmannii***

7a Stromatal surface some shade of rose or purple 8

7b Stromatal surface bright red to reddish brown, straw colored or brown, never purple 9

8a Stromata purple red (K. & W. pl.10F5) ; ascospores 7.5-9 x 3.5-4.5 µm, perispore ornamented with faint transverse striations only seen by S.E.M.
H. sp., a member of the rubiginosum complex

8b Stromata greyish rose (K. & W. pl.9D4) ; ascospores 9-12 x 4-5.5 µm, perispore ornamented with transversely oriented ribs ***H. retpela***

9a Surface bright red to reddish brown (K. & W. pl.8D7), perithecia tubular, soft, easily separating ; ascospores 13-14 x 5.5-8 µm, perispore ornamented with faint transverse striations, only seen by S.E.M. ***H. haematostroma***

9b Surface reddish brown, straw colored or brown, perithecia oval to globose, not easily separating ; ascospores smaller, perispores ornamented with transversely oriented ribs 10

10a Stromata brown with red tones (K. & W. pl.7E4) ; ascospores inaequilaterally ellipsoid to navicular, 7-8 x (3) 3.5-4 µm, with a sigmoid germ slit, full length ***H. hypomiltum***

10b Ascospores inaequilaterally ellipsoid, larger, with a straight germ slit, full length on the convex side of the spore 11

11a Stromata brownish orange to rusty red (K. & W. pl.6ED5) ; ascospores 8-11 x 4-5 µm ***H. subgilvum***

11b Stromata bright orange (K. & W. pl.5B6) ; ascospores 13.5-15 x 6-7 µm ***H. crocopeplum***

12a Ostioles simply papillate, not surrounded by an annular disc (section *Papillata* subsection *Papillata*) ; stromata indefinitely effused, some shade of orange brown, rusty brown when young, later dark purplish red to black (pl.6E8→7E8) ; ascospores (6.5) 7-9.55 (11) x 3-4 (4.5) µm ***H.* cf. *investiens***

12b Perithecial ostioles papillate in a flattened disc (section *Annulata*) 13

13a Stromata with wide ostiolar discs, 0.6-0.8 mm in diameter 14

13b Stromata with ostiolar discs less than 0.6 mm in diameter 15

14a Stromata large, subglobose to hemispherical, 1.5-3 cm in diam. ; ascospores 9.5-12.5 x 4.5-5.5 µm ***H. macroannulatum***

14b Stromata pulvinate with forms separating into individual perithecia ; ascospores 9-10.5 x 4-5 µm ***H. bovei* var. *microsporum***

15a Ostiolar disc (0.3) 0.4-0.55 mm diam ; ascospores medium brown, 6.5-9.5 x 3.5-5.5 µm ***H. truncatum***

15b Ostiolar disc 0.1-0.3 mm diam 16

16a Perithecia widely dispersed in an undulating stroma, border of discs wide, flat ; ascospores (9.5) 10-14 x (4) 4.5-6 µm ***H. subannulatum***

16b Perithecia closely placed in stroma, border of discs sharply defined 17

17a Perithecial discs flat to concave ; ascospores 5-8 x 2.5-3.5 µm ***H. stygium***

17b Perithecial discs convex ; ascospores (8) 9-11 x 3.5-5 µm ***H. archeri***

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COMPUTER CODING OF STRAIN FEATURES OF THE GENUS PYTHIUM

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ABSTRACT

The fungal genus *Pythium* is a large group of aquatic and terrestrial species that are essentially worldwide in distribution. Identification of *Pythium* isolates to species level is often difficult because species are separated mainly by quantitative differences in the morphology of reproductive structures that are frequently overlapping in some species or absent in others. A data coding system used for computer storage and analysis of microbial strain data was expanded to include features specifically applicable to the identification of *Pythium* species.

BACKGROUND AND DISCUSSION

The genus *Pythium* includes over 180 species that are commonly found in soil and water (Waterhouse, 1967, 1968). *Pythium* species are saprophytic or parasitic on a wide variety of plants, attacking primarily the juvenile or succulent tissues and causing serious seed rot and damping-off of seedlings, root rot, fruit rot, and vegetable rot (Hendrix and Campbell, 1973). Some species also attack algae, fungi, animals, and humans (Middleton, 1943; Bissonnette *et al.*, 1991; Deacon *et al.*, 1991).

Identification of *Pythium* species has always been difficult since keys are based almost exclusively on morphological criteria such as the shape and size of sporangia, oogonia, oospores, and antheridia (Matthews, 1931; Middleton, 1943; Waterhouse, 1967, 1968; Hendrix and Papa, 1974; Van der Plaats-Niterink, 1981; Dick, 1990). However, these characters may be overlapping in some species or absent in others, and the range of variation within a species is often unknown. Van der Plaats-Niterink (1981) used physiological characteristics such as optimum and maximum growth temperatures and daily growth rate as supplementary diagnostic criteria. More recently, other methods have been investigated as additional means of distinguishing between two or more species of *Pythium*. These methods include gel electrophoresis of mycelial proteins (Adaskaveg *et al*., 1988; Chen *et al*., 1988, 1991; Yu and Ma, 1989); isozyme analysis (Chen *et al*., 1989, 1991; Yu and Ma, 1989); serology tests (Krywienczyk and Dorworth, 1980); and analysis of total, ribosomal, and mitochondrial DNA (Martin and Kistler, 1987; Belkhiri and Dick, 1988; Martin, 1991; Chen *et al*., 1990). Attempts have also been made to develop probes specific for species or isolates of *Pythium* by identifying the unique DNA sequences in mitochondrial DNA (Martin, 1990).

None of the methods that have been described for *Pythium* species can be used as a definitive or universal method of identification for all species. Consequently, identification of a *Pythium* strain to the species level can be difficult and time consuming. A protocol combining all features previously found to be important in the differentiation of *Pythium* species would be of great value. Use of a standardized coding system for these features would facilitate computer storage, retrieval, analysis, and exchange of data on *Pythium* strains as well as development of identification keys or probability matrices. In this communication, we present a comprehensive set of features important in the identification of *Pythium* species. These features have been incorporated into an existing computer coding system, the RKC Code, and can be used for identification purposes, information retrieval, and communication.

The RKC Code (after the original authors -- Rogosa, Krichevsky, and Colwell, 1971) is an open-ended, statement-oriented controlled vocabulary of descriptors of strain characteristics or features. The RKC Code was developed originally for bacterial strains (Rogosa *et al*., 1971) and was later expanded to include features specific for algae (Van Valkenburg *et al*., 1977), protozoa (Daggett *et al*., 1980), and selected groups of fungi (Philpot *et al*., 1982). In 1986, the expanded RKC Code was published under the auspices of the Committee on Data for Science and Technology (CODATA) (Rogosa *et al.*, 1986). More recently, the RKC Code was further expanded to include characteristics specific for yeasts (Jong *et al.*, 1988), the fungal genus *Phytophthora* (Jong *et al.*, 1989), and the saprolegnian fungi (Jong *et al.*, 1991). The Code currently includes more than 12,000 strain descriptors.

The RKC Code is the standardized vocabulary used in the Microbial Information System (MICRO-IS), a comprehensive system of computer programs for storage, management, and analysis of data on microbial strains (Krichevsky, 1987). MICRO-IS has been used by the staffs of the American Type Culture Collection (ATCC) and the Microbial Systematics Section of the National Institute of Dental Research at NIH for managing and analyzing microbial data and in collaborative efforts with other microbiologists to share information resources. Data are encoded and entered into the computer using the unique code numbers that represent the full statement definitions of individual strain features. A computer-managed set of data encoded using features such as those presented here could enable the investigator to enter data on a new strain and use computer programs to aid in identification by use of keys or probability calculations. Even when computer analysis does not give a definitive identification, the number of species that has to be researched further is reduced, and the results may suggest additional tests that can improve the identification. This is an accurate and more convenient and rapid alternative to doing the entire process manually. Additionally, data encoded in this manner can be used to build computer databases for study of taxonomic relationships and construction of identification keys or probability matrices and for sharing data with collaborators.

The set of characteristics developed for use in the identification of *Pythium* species is presented in the list below. Although some of these features were already part of the RKC Code, many of the descriptors are unique to *Pythium* species and were created specifically for this genus. New features added to the RKC Code for the *Pythium* species are marked with an "*" in the list. The features include morphological descriptions of sporangia, zoospores, sexual organs, hyphae, and chlamydospores; colony characteristics; and growth temperatures. The terms used for morphological descriptions are based on the descriptions given in Hawksworth *et al.*, 1983.

ASEXUAL REPRODUCTION

- Sporangia

*043074: Sporangia are present.
008779: Sporangia are produced on agar medium.
008781: Sporangia are produced in water.
008782: Sporangia are produced in liquid growth medium.
*043075: Sporangia are sessile.
008811: Sporangia are terminal.
008812: Sporangia are intercalary.
008570: Sporangia are produced laterally.
*043076: Sporangia are contiguous.
008566: Sporangia occur singly.
008809: Sporangia proliferate internally.
*043077: Proliferating sporangium forms new sporangium inside the old sporangial wall.
*043078: Sporangia are deciduous (shed at maturity).
008800: Sporangia have papillae.
*043079: Sporangia are filamentous (undifferentiated from vegetative hyphae).
*043080: Sporangia are delimited from hyphae by septa.
*043081: Sporangia are inflated.
*043082: Sporangia are branched.
008553: Sporangia are digitate.
043039: Sporangia are lobate.
008558: Sporangia are spherical (length to breadth ratio is 1.0-1.05).
008815: Sporangia are prolate spheroidal (length to breadth ratio is 1.06-1.15).
008774: Sporangia are ellipsoidal (length to breadth ratio is 1.31-1.6).
008773: Sporangia are ovoid (egg-shaped, attached at broad end).
008816: Sporangia are obovoid (egg-shaped, attached at narrow end).
008817: Sporangia are limoniform (lemon-shaped, citriform).

008818: Sporangia are pyriform (pear-shaped, attached at narrow end).
008819: Sporangia are obpyriform (pear-shaped, attached at broad end).
008552: Sporangia are cylindrical.
008821: Sporangia are bursiform (pouch-shaped).
008555: Sporangia are irregular in shape.
*043083: Sporangia are < 11 μ long.
008574: Sporangia are 11-15 μ long.
008575: Sporangia are 16-20 μ long.
008576: Sporangia are 21-30 μ long.
008981: Sporangia are 31-40 μ long.
008982: Sporangia are 41-50 μ long.
008838: Sporangia are 51-60 μ long.
008839: Sporangia are 61-70 μ long.
008840: Sporangia are 71-80 μ long.
008841: Sporangia are 81-90 μ long.
008842: Sporangia are 91-100 μ long.
008843: Sporangia are > 100 μ long.

- Zoospores

008752: Zoospores (motile spores) are produced.
*043084: Zoospores are < 8 μ in diameter.
*043085: Zoospores are 8-10 μ in diameter.
*043086: Zoospores are 11-13 μ in diameter.
*043087: Zoospores are 14-16 μ in diameter.
*043088: Zoospores are 17-19 μ in diameter.
*043089: Zoospores are > 19 μ in diameter.
*043090: Zoospores are bean-shaped (reniform).
*043091: Zoospores are pear-shaped.
008854: Zoospores of sporangia are released naked (unencysted).
*043092: Zoospore cysts are < 7 μ in diameter.
*043093: Zoospore cysts are 7-9 μ in diameter.
*043094: Zoospore cysts are 10-12 μ in diameter.
*043095: Zoospore cysts are 13-15 μ in diameter.
*043096: Zoospore cysts are 16-18 μ in diameter.
*043097: Zoospore cysts are > 18 μ in diameter.

- Zoospore Flagellation

013381: Zoospores have flagella.
013382: Zoospores are biflagellate.
013384: Whiplash flagella (lacking obvious scales or mastigonemes) are produced.
013385: Tinsel flagella (bearing mastigonemes) are produced.
013386: Anterior flagella are of whiplash type.
013387: Anterior flagella are of tinsel type.
013388: Posterior flagella are of whiplash type.
013389: Posterior flagella are of tinsel type.

- Chlamydospores

008363: Chlamydospores are present.
*043172: Chlamydospores are < 21 μ in diameter.
*043173: Chlamydospores are 21-25 μ in diameter.
*043174: Chlamydospores are 26-30 μ in diameter.
008933: Chlamydospores are 31-35 μ in diameter.
*043175: Chlamydospores are 36-40 μ in diameter.
*043176: Chlamydospores are 41-45 μ in diameter.
*043177: Chlamydospores are 46-50 μ in diameter.
*043178: Chlamydospores are > 50 μ in diameter.
*043179: Chlamydospore walls are 1-2 μ thick.
*043180: Chlamydospore walls are 3-4 μ thick.
*043181: Chlamydospore walls are 5-6 μ thick.

SEXUAL REPRODUCTION

008617: Sexual reproduction occurs.
008618: Strain is homothallic (both mating types on same mycelium).
008619: Strain is heterothallic (mating types on separate mycelia).

- Antheridia

008880: Antheridia are present.
043005: Antheridia are monoclinous (on oogonial stalk).

043006: Antheridia are diclinous (not on same hypha as oogonium).
008883: Antheridia are paragynous (on one side of oogonium).
043003: Antheridia are hypogynous (directly under oogonium on same hypha).
008890: Antheridia twist around oogonial stalks.
*043098: Antheridia are stalked.
*043099: Antheridia are terminal.
*043100: Antheridia are intercalary.
*043101: Antheridia are lateral.
*043102: Antheridia are cylindrical.
*043103: Antheridia are campanulate (bell-shaped).
008897: Antheridia are clavate (club-shaped).
*043104: Antheridia are crook-necked (curved sharply).
008887: Antheridia are contorted.
008888: Antheridia are lobed.
008889: Antheridia are branched.
*043105: Antheridia are furrowed.
*043106: Antheridia are coralloid (branched like coral).
*043107: Antheridial diameter is uniform.

- Oogonia

008899: Oogonia are present.
*043108: Oogonium has one antheridium.
008903: Oogonium has two antheridia.
008904: Oogonium has three antheridia.
*043109: Oogonium has four antheridia.
*043110: Oogonium has five antheridia.
*043111: Oogonium has 6-10 antheridia.
*043112: Oogonium has 11-15 antheridia.
*043113: Oogonium has 16-20 antheridia.
*043114: Oogonium has more than 20 antheridia.
*043115: Oogonial stalk curves towards the antheridium.
008900: Oogonia occur singly.
*043116: Oogonia are catenulate (in chains).
*043117: Oogonia are sessile.
*043118: Oogonia are terminal.
*043119: Oogonia are intercalary.
*043120: Oogonia are lateral.

008915: Oogonia are spherical (length to breadth ratio is 1.0-1.05).
043016: Oogonia are prolate spheroidal (length to breadth ratio is 1.06-1.15).
043017: Oogonia are broadly ellipsoidal (length to breadth ratio is 1.16-1.30).
043018: Oogonia are ellipsoidal (length to breadth ratio is 1.31-1.6).
*043121: Oogonia are limoniform (lemon-shaped).
*043122: Oogonia are irregular in shape.
*043123: Oogonia are < 11 μ in diameter.
*043124: Oogonia are 11-20 μ in diameter.
*043125: Oogonia are 21-30 μ in diameter.
*043126: Oogonia are 31-40 μ in diameter.
*043127: Oogonia are 41-50 μ in diameter.
*043128: Oogonia are 51-60 μ in diameter.
008921: Oogonia are > 60 μ in diameter.
008905: Surfaces of oogonia are smooth.
043012: Surfaces of oogonia have papillate projections.
043013: Surfaces of oogonia have spiny projections.
*043129: Oogonial projections are branched at the tips.
*043130: Oogonial projections are conical.
*043131: Oogonial projections are cylindrical.
*043132: Oogonial projections are 1-2 μ long.
*043133: Oogonial projections are 3-5 μ long.
*043134: Oogonial projections are 6-8 μ long.
*043135: Oogonial projections are 9-12 μ long.
*043136: Oogonial projections are > 12 μ long.

- Oospores

043026: Oospores are present.
043027: Oogonium has one oospore.
*043137: Oogonium has two oospores.
*043138: Oogonium has more than two oospores.
008922: Oospores are plerotic (fill the oogonium).
*043139: Aplerotic index (oospore/oogonium volume) is $< 60\%$.
*043140: Aplerotic index (oospore/oogonium volume) is 60-65%.
*043141: Aplerotic index (oospore/oogonium volume) is 66-70%.
*043142: Aplerotic index (oospore/oogonium volume) is 71-75%.

*043143: Aplerotic index (oospore/oogonium volume) is 76-80%.
*043144: Aplerotic index (oospore/oogonium volume) is > 80%.
*043145: Surfaces of oospores are smooth.
*043146: Surfaces of oospores are reticulate.
*043147: Surfaces of oospores are papillate.
*043148: Oospores are hyaline.
*043149: Oospores are pigmented.
*043150: Oospores are yellow.
*043151: Oospores are violet.
*043152: Oospores are < 11 μ in diameter.
*043153: Oospores are 11-20 μ in diameter.
008924: Oospores are 21-30 μ in diameter.
008925: Oospores are 31-40 μ in diameter.
008926: Oospores are 41-50 μ in diameter.
*043154: Oospores are 51-60 μ in diameter.
*043155: Oospores are > 60 μ in diameter.
*043156: Oospore walls are < 1 μ thick.
008928: Oospore walls are 1-3 μ thick.
008929: Oospore walls are 4-5 μ thick.
*043157: Oospore walls are 6-8 μ thick.
*043158: Oospore wall index (oospore wall/oospore volume) is < 30%.
*043159: Oospore wall index (oospore wall/oospore volume) is 30-35%.
*043160: Oospore wall index (oospore wall/oospore volume) is 36-40%.
*043161: Oospore wall index (oospore wall/oospore volume) is 41-45%.
*043162: Oospore wall index (oospore wall/oospore volume) is 46-50%.
*043163: Oospore wall index (oospore wall/oospore volume) is 51-55%.
*043164: Oospore wall index (oospore wall/oospore volume) is >55%.

- Ooplasts

*043165: Ooplasts are present.
*043166: Ooplast index (ooplast/oospore volume) is < 20%.
*043167: Ooplast index (ooplast/oospore volume) is 20-25%.

*043168: Ooplast index (ooplast/oospore volume) is 26-30%.
*043169: Ooplast index (ooplast/oospore volume) is 31-35%.
*043170: Ooplast index (ooplast/oospore volume) is 36-40%.
*043171: Ooplast index (ooplast/oospore volume) is > 40%.

HYPHAE

*043182: Hyphae are 1-2 μ in diameter.
008943: Hyphae are 3-4 μ in diameter.
008944: Hyphae are 5-6 μ in diameter.
008945: Hyphae are 7-8 μ in diameter.
008946: Hyphae are 9-10 μ in diameter.
008008: Secondary (aerial) hyphae are produced.
008348: Hyphae have swellings (bodies) (outside diameter varies).
008963: Hyphal swellings (bodies) are terminal.
008964: Hyphal swellings (bodies) are intercalary.
008956: Hyphal swellings (bodies) are catenulate (in chains).
008961: Hyphal swellings (bodies) are irregular in shape.
008958: Hyphal swellings (bodies) are ellipsoidal.
008957: Hyphal swellings (bodies) are spherical.
*043183: Hyphal swellings (bodies) are lobed.
*043184: Hyphal swellings (bodies) are < 11 μ in diameter.
*043185: Hyphal swellings (bodies) are 11-20 μ in diameter.
*043186: Hyphal swellings (bodies) are 21-30 μ in diameter.
*043187: Hyphal swellings (bodies) are 31-40 μ in diameter.
*043188: Hyphal swellings (bodies) are 41-50 μ in diameter.
*043189: Hyphal swellings (bodies) are > 50 μ in diameter.
*043190: Hyphal swellings (bodies) are deciduous (shed at maturity).

COLONY CHARACTERISTICS ON SOLID MEDIA

NOTE: Recommended media for observing colony characteristics for *Pythium* species are corn meal agar and potato/carrot agar (Van der Plaats-Niterink, 1981), incubated at 25°C.

016549: Agar macrocolony has uniformly radiate hyphae.
016576: Agar macrocolony has broad, rounded petal-shaped sectors.

016575: Agar macrocolony has narrow petal-shaped sectors.
*016629: Diameter of colony increases by < 1 mm per day.
016552: Diameter of colony increases by 1-5 mm per day.
016553: Diameter of colony increases by 6-10 mm per day.
*016630: Diameter of colony increases by 11-15 mm per day.
*016631: Diameter of colony increases by 16-20 mm per day.
*016632: Diameter of colony increases by 21-25 mm per day.
*016633: Diameter of colony increases by 26-30 mm per day.
*016634: Diameter of colony increases by 31-35 mm per day.

GROWTH TEMPERATURE AND NUTRITION

017032: Growth occurs at 5°C.
017012: Growth occurs at 10°C.
017013: Growth occurs at 15°C.
017037: Growth occurs at 20°C.
017014: Growth occurs at 25°C.
017033: Growth occurs at 30°C.
017034: Growth occurs at 35°C.
017043: Growth occurs at 40°C.
017017: Growth occurs at 45°C.
017001: The optimum temperature range for growth is 0-10°C.
017002: The optimum temperature range for growth is 11-20°C.
017003: The optimum temperature range for growth is 21-30°C.
017004: The optimum temperature range for growth is 31-40°C.
016114: Thiamine is required for growth.

SOURCE OF ISOLATION

002012: What was the specific source of isolation (e.g., kind of water, soil, etc., species and organ and tissue of plant, animal, etc.)?

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THE TAXONOMY OF THE LIST OF FUNGAL NAMES FOR THE PROPOSED "GENERIC NAMES IN CURRENT USE" MODIFICATION OF THE INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE.

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> *"A taxonomic system is generally considered to have two functions. The first function is to provide an index to species."..."The second function is to show the phylogenetic relationships among these species. Taxonomy, then, is concerned with the naming, classification, and identification of species and with phylogeny."* E.S. Luttrell, 1958 The function of taxonomy in mycology. Mycologia 4: 942-944.

ABSTRACT

The originators of the proposed modification of the International Code of Botanical Nomenclature entitled "Generic Names in Current Use" have invited constructive criticism of the plan to protect, via an approved list, botanical names used in recent literature. The concerns expressed in this paper relate to the taxonomic organization of the "Draft Lists for Fungi" (DLF). Two issues are discussed. (1) Names of phylogenetically non-fungal taxa are included in the DLF, implicit recognition of "Fungal" standing . The Code should reflect a current state of knowledge of the affinities of these taxa. (2) Appendix V, Generic Names in Current Use, should be an alphabetical, non-taxonomic list of generic names applied to members of the polyphyletic "fungal" assemblage. The Index to Appendix V should not be interpreted as part of the Code, and should reference names by taxonomy.

INTRODUCTION

Modification of the International Code of Botanical Nomenclature (ICBN) through the Generic Names in Current Use (GNCU) list, would constitute a starting point that supersedes those already recognized (Art. 13). The listed names are to be given protection from earlier names which do not appear in the lists.

Greuter (1991) gave assurances concerning the Names in Current Use (NCU) effort. *"The listing must not result in any kind of taxonomic censorship; when competing systems of classification or divergent notions of taxon delimitation, position or rank exist, all names reflecting the various opinions are to be listed"* ... *"Approved lists must essentially remain stable once and forever; nevertheless a certain amount of flexibility must be provided in* *order to enable desirable corrections and perhaps additions, and mechanisms to that effect must be provided." ... "The proposed NCU provisions are designed to become an integral part of the Code, not to displace its present provisions." ... "priority will determine the choice between competing protected names...".*

The Draft Lists for Fungi (DLF), prepared under the guidance of an International Association for Plant Taxonomy Secretariat Committee for Fungi and Lichens, is composed of generic names organized using supra-generic taxa. The finalized Lists for Fungi are to be added to the ICBN as Appendix V.

The unprecedented NCU movement could have an unintended influence on taxonomy. While the ICBN modification is related to the names *per se*, the provision of these names in a taxonomic framework is likely to compound ambiguities of the ICBN. Our concern is that the implicit endorsement of a taxonomic framework of the lists will be taken as a codified, stable (non-changing) understanding of the higher relationships of the "fungi".

Here are our thoughts about the GNCU-Draft Lists for Fungi as a taxonomic device for nomenclatural purposes.

1. What are fungi? The naming of what organisms are governed by the ICBN rules?

Preamble 7 states that the ICBN applies to all organisms (historically) treated as plants, including the fungi. The ICBN freely uses the word "fungus" and its grammatical variants, but no definition, except by default and incidental exception, is provided for what organisms are to be regarded as fungi. The ICBN regulation of "fungi" is a matter of what taxa are assigned to that *nomen vulgaris* by the code. The historical basis for defining the fungi is simply that they are those organisms traditionally studied by mycologists. These are "fungi", spelled with a lower case first letter, and are a polyphyletic gathering of organisms that lack chlorophyll. In this respect, the traditional ICBN use of a fungus concept reflects names in "modern languages, the applications of which are often doubtful" (Art. 32.E.1).

One of the alternative bases for a definitive use of fungus (fungi pl.), other than botanical tradition, is natural, phylogenetic classification. A phylogenetic definition of Fungi based on an assessment of current data can be found in Bruns, *et al.* (1991). The kingdom Fungi, spelled with an upper case first letter, is a monophyletic taxon composed of the Basidiomycota, Ascomycota, Zygomycota, and the Chytridiomycota. (The Zygomycota was not included in the assessment for lack of data, but is thought to fall within the "true fungi".)

Some of the Myxomycota are more closely related to protozoan taxa than to the Fungi. The Oomycetes and Hyphochytriomycetes are more closely related to chrysophyte algae (Förster *et al.*, 1990; Lee, 1991). These nonfungal groups of organisms are inadvertently given fungal standing with the formation of higher taxa names using the endings found in ICBN Recommendation 16A.

Patterson and Larsen (1991) noted that taxa such as protists are ambiregnal if their nomenclature legitimately can be regulated by the provisions of the ICBN or by those of the International Code of Zoological Nomenclature. Olive (1975) cited the taxa of the acrasiaceous and acytosteliad organisms in the Protozoa with animal kingdom word terminations.

2. An alphabetical list of generic names should be used in the Lists for Fungi. A taxonomic index to the generic names of this polyphyletic assemblage would be useful.

An alphabetical listing of the generic names in Appendix V will minimize undesired effects of incorporation of taxonomy in a nomenclatural document.

However, to provide for the practical needs of fungal nomenclaturalists, taxonomists, and other "user groups" (Hawksworth and Greuter, 1989) who will consult the GNCU lists, a taxonomic index of the generic names of the "fungi" should be provided. The taxonomy used in the Draft Lists for Fungi is outlined in Figure 1. Major group names used are Ascomycotina, Deuteromycotina, Gasteromycetes, Hymenomycetes, Mastigomycotina, Myxomycetes, Urediniomycetes, and Incertae Sedis.

Unfortunately, the taxonomic model of the Draft Lists, meant to index the codified names, is not especially informative, and in some cases is misleading. If taxonomy is a means of information retrieval, via classification together of organisms of common descent, the taxonomy of the Draft Lists for Fungi contains serious flaws.

The Myxomycetes is composed of phylogenetically unrelated plasmodial, cellular, plasmodiophoroid, and labryinthuloid "slime mold" taxa.

The Mastigomycotina is composed of the Oomycetes, Hyphochytridiomycetes (Hyphochytriomycetes), Chytridiomycetes, Trichomycetes, and Zygomycetes. The first two classes are allied with various algal groups, while the other three are allied with the Ascomycotina and Basidiomycotina in the Fungi.

The commonly used sub-division level taxon Basidiomycotina is conspicuously absent from the major group headings. Instead, several of its component class level taxa are used. These are the Gasteromycetes, Hymenomycetes, and Urediniomycetes. Within the Hymenomycetes are the order level taxa Agaricales (gilled mushrooms, excluding the boletes), Aphyllophorales, and a group of fungi under the heading Hymenomycetes, including boletes, the tremelloid, dacrymycetoid, and auricularioid jelly fungi, the tulasnelliod fungi, and various other basidiomycetous fungi.

The class Urediniomycetes is confusingly composed of two other class level taxa, the

Urediniomycetes (rusts), and Ustilaginomycetes (smuts).

How should the taxonomic index be provided?

One model for listing organisms is provided in ICBN Appendix IIIA. *Nomina generica conservanda et rejicienda*. The conserved fungal names are listed alphabetically, without a higher taxonomic framework. This alphabetical listing is a result of regarding fungi as a group of organisms traditionally studied by mycologists rather than as a monophyletic group of organisms. The Index to Appendix IIIA of the ICBN is a separate, alphabetical list of all conserved and rejected names, provided without reference to taxonomy. The generic names for algae, and gymnospermous and angiospermous plants are organized taxonomically in Appendix III. However, there is no taxonomic index of the conserved fungal names; they are included in an alphabetical index containing all of the generic names conserved under the ICBN.

In order to maximize usefulness and biological information content, the index should be consistent with the current state of knowledge at the time of any particular ICBN edition concerning the phylogentic relationships of the taxa named on the lists.

To bring the current Draft Lists for Fungi into current status, the implied taxonomy in Article 13(d) should be disregarded. The Myxomycetes should be distributed into appropriate non-fungal groups which recognize the separate origins of the plasmodial slime molds, cellular slime molds, and the various other disparate taxa included therein. The Mastigomycotina of the lists should be dissolved; the Oomycota and Hyphochytriomycetes names should be listed as separate algal divisions. Under the main heading Kingdom Fungi, division level names should be used. The Trichomycetes, Zygomycetes of the Zygomycota, and Chytridiomycota names should be placed with the Ascomycota and Basidiomycota in the kingdom Fungi. Order level names should be used for each division, as in the Ascomycota list. The Deuteromycetes is a phylogenetic non-concept, and should not be used.

The usefulness of the indexing is not to be measured in its congruence with old-line mycological taxonomic thought, but with the amount of biological information it conveys. A phylogenetic scheme is the best way to organize such information.

CONCLUSIONS

The fungal taxa in Appendix V of the ICBN should be free of taxonomy. A separate, non-codified Index to Appendix V should be taxonomically organized for best practical use. Phylogenetic taxonomic groupings are proposed as the most informative method by which to index the names. Phylogenetically unrelated taxa now regarded under the heading of "fungi" in the ICBN should be indexed to reflect the current state of knowledge as to phylogenetic relationships.

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Figure 1
Outline of the Taxonomic Organization of the GNCU-DLF

- I. **Ascomycotina**
  - 38 orders of ascomycetes
  - Ascomycotina
- II. **Deuteromycotina**
  - Agaricales
  - Aphyllophorales
  - Coelomycetes
  - Colomycetes (Typographical error)
  - Deuteromycotina
  - Gasteromycetes
  - Hymenomycetes
  - Hypocreales
  - Leotiales
  - Myxomycetes
  - Urediniomycetes
  - Ustilaginomycetes
  - Zygomycetes
- III. **Gasteromycetes**
- IV. **Hymenomycetes**
  - Agaricales
  - Aphyllophorales
  - Basidomycotina
  - Hymenomycetes
- V. **Mastigomycotina**
  - Chytridiomycetes
  - Hyphochytridiomycetes
  - Mastigomycotina
  - Oomycetes
  - Trichomycetes
  - Zygomycetes
- VI. **Myxomycetes**
  - Myxomycetes
  - Myxomycotina
- VII. **Urediniomycetes**
  - Urediniomycetes
  - Ustilaginomycetes
- VIII. **Insertae Sedis**
  - Ascomycotina
  - Coelomycetes
  - Hyphomycetes
  - Incertae Sedis

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NEW COMBINATIONS IN THE GENUS HYMENOSCYPHUS (HELOTIALES)

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KEYWORDS: *Hymenoscyphus*, *H. callorioides*, *H. citrinicolor*, *H. pallide-subolivaceus*, *H. tatrae*, Helotiales, Leotiaceae.

During a comprehensive study of the genus *Hymenoscyphus* S.F.Gray twenty-three species were recognized in Slovakia, Czechoslovakia. In advance of the forthcoming monograph (Lizoň, 1992), I propose following new combinations.

Hymenoscyphus callorioides (Rehm) **comb. n.**
Basionym: *Helotium callorioides* Rehm, Hedwigia 21:98, 1882.

The type material consists of two types of fruit-bodies: about 7 sessile apothecia of *Hymenoscyphus callorioides* and 2-3 stipitate apothecia that are probably *Hymenoscyphus repandus* (Phill.) Dennis. Apothecia of *H. callorioides* are broadly sessile, brownish-orange and to 0.5 mm diam. when dry; disc is plane to plano-convex. Ectal excipulum forms a thin layer up to 40 µm thick, composed of thin-walled cells, lying in rows parallel to the surface. Ascus pore blues in Melzer's reagent. Spores are ellipso-fusoid, nonseptate, hyaline, (8.5)11.0-12.5 x 1.5-2.5 µm.

HOLOTYPE: [Austria] An faulenden *Aconitum varieg.* beim Kartel-Gletscher (Moosthal) im Tyrol, c. 2000 m, 7/1878, Britzlmayer (S, herb. H. Rehm).

Hymenoscyphus pallide-subolivaceus (Svr.) **comb. n.**
Basionym: *Helotium pallide-subolivaceum* Svrček, Čes.Mykol. 12:228, 1958.

I have examined a part of the holotype including a leaf of *Vaccinium* with one fruit-body on the upper side of the leaf blade, a spruce needle with two fruit-bodies, and a fir needle bearing no fruit-bodies. Apothecia are apricot-yellow when dry, about 0.3 mm diam., short-stipitate; stipe is concolorous, 0.1 x 0.1 mm. Ectal excipulum is composed at the base of the receptacle of large cells, 15 x 5 µm, with slightly thickened walls, elongated towards the margin and forming a layer of narrow, thin-walled hyphae, 2.0 - 4.0 µm diam. Ascus pore blues only weakly in Melzer's reagent. Spores are ellipso-clavate to fusoid-clavate, some of them irregular, nonseptate, 10.2-12.5 x 1.8-2.5 µm.

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[1] Anna E. Jenkins Visiting Fellow

HOLOTYPE: [Czechoslovakia] Slovakia, in montibus Belanské Tatry, supra Tatranská Kotlina, 1100 m s.m., Ad acus *Abietis albae*, *Piceae abietis*, folia *Vaccinii myrtilli* etc., 19.V.1958, J. Kubička & M. Svrček (PRM 586641).

Hymenoscyphus tatrae (Svr.) **comb. n.**
Basionym: *Helotium tatrae* Svrček, Čes.Mykol. 12:228, 1958.

I have studied a part of the holotype which contains 3 pieces of larch needles with 3 young (not fully mature) fruit-bodies. Apothecia are yellowish and 0.2 - 0.5 mm diam. when dry, cupulate, short-stipitate. Stipe is paler, about 0.5 x 0.1 mm (1.5x longer than diameter of the receptacle). Ectal excipulum is composed at the base of the receptacle of globular cells, 4.5 - 8.0(14.5) µm diam., towards the margin this structure is replaced by cylindric to clavate cells. Ascus pore blues only weakly in Melzer's reagent. Spores are ellipsoid to ellipso-cylindric, nonseptate, 8.8-11.0 x 1.5-2.5 µm. Fruit-bodies on *Carex flacca* subsp. *claviformis*, as reported in the original description (Svrček, l. c.), have not been available from PRM.

HOLOTYPE: [Czechoslovakia] Slovakia, in montibus Belanské Tatry, supra Tatranská Kotlina, 1250 m s.m., Ad acus *Laricis deciduae* subsp. *polonicae*, 19.V.1958, J. Kubička & M. Svrček (PRM 856642).

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CHAETOPSINA NIMBAE, A NEW SPECIES OF DEMATIACEOUS HYPHOMYCETES

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Abstract

Chaetopsina nimbae, a new species of Dematiaceous Hyphomycetes, collected on fallen leaves of *Lophira alata* Banks ex Gaertn. is described. The morphology and some physiological characters are compared with features of a strain of *Chaetopsina fulva* Rambelli.

Introduction

Chaetopsina fulva Rambelli (1956) is a Dematiaceous Hyphomycete characterized by great variability. The species was subsequently found on litter by several investigators, even if with some morphological differences, in various geographic areas (Tubaki & Saito, 1969; Matsushima, 1975; Samuels, 1985; Kirk, 1982; Rambelli, 1987; Rambelli *et al.*, 1991, 1991a, 1991b).

During some mycological investigations, carried out in 1989 on Guinea Conacry tropical forest litter, a species of *Chaetopsina* was collected on dead leaves of *Lophira alata*. In the same year, in surroundings of Rome, a second strain was found on dead leaves of *Cedrus deodara* (D.Don) G. Don fil. Owing to the great morphological variability of the fungus, the strains were initially included in the species "*fulva*" even if the African one showed some differences in morphology, growth of its colonies and size of its conidia.

In the present work the morphological and some physiological characters of the two strains are investigated in order to verify their specific identity. They are respectively labelled CR1 for the Italian strain and CA2 for the African one.

Materials and methods

Morphological investigations were carried out on natural substrates, in pure cultures (Rambelli *et al.*, 1991b) and on sterilized and inoculated substrates (Kabi & Rambelli, 1990; Rambelli *et al.*, 1991a).

The strains were also tested with respect to their vitamin requirements: a hyphal suspension was inoculated in a agar minimum medium (Czapek) and 0.1 ml of a successive 50% dilution of vitamin complex (composed per ml by vitamin A (u.l. 5000), B1(mg 2), B2 (mg 1.27), Nicotinamide (mg 10), B6 (mg 1), Pantothenol (mg 10), Biotin (mg 0.1), C (mg 50), D2 (u.l. 1000), E (mg 3)) added in a hole cut in the agar plate. Control was carried out with sterilized water.

Slide microcultures were prepared in order to verify the possibility of hyphal connections between the two strains.

Results

CR1 morphological characters.

Microscopic characters on natural substrates, as morphology and sizes, are similar to *C. fulva.* The strain differs only in the strong pigmentation of the walls and in the frequent apical fertility of the conidiophores. This last character seems an anomalous behaviour of the fungus, presumably of nutritional origin (Rambelli *et al.*, 1991). In pure culture the fungus colonizes the medium very fast. The mycelium is prevalently immersed and the surface of the colony is frequently shiny, brown-blackish at the center and red-brown to whitish at the periphery. It grows easily on different media (Mycological, PDA, etc), but not on Czapek agar (Rambelli *et al.*, 1991a).

CA2 morphological characters.

CA2 strain produces, on natural substrates, some unripe globose ascoma like structures (fig. 1a); these structures are spherical, with membranous walls, with evident peridial cells and with only rare hyphae near the base, red-yellow-brown in colour, 118-268 μm in diameter. Some ascogenous hyphae are evident in these structures, but the production of asci has never been observed. The anamorph (fig. 1b, c) is developed from the cells of the wall of this unriped body; it is represented by setiform conidiophores, light yellow, paler towards the apices and with clearly visible septa; they are thick walled, with lighter in colour and chlorine walls wich are coarsely roughened in the last five or six apical cells. The setiform conidiophores are regularly curved on the fertile side. They are 214-392 x 7.5-13 μm. The phialidic conidiogenous cells (Fig. 1b) are 4-5 x 2-3 μm. The conidia are very similar to those of *C. fulva* (*C.fulva* conidia 7.5-10.8 x 1-1.5 μm) and only differ in their size (11-16 x 2-2.5 μm). In Czapek agar pure cultures the growth of the fungus is regular with mycelium prevalently light yellow, immersed only at the center, where unripe globose perithecium like structures and conidiophores of the anamorph are produced; these structures give a granular appearance and a reddish colour to the colony (Rambelli *et al.*, 1991a).

Behaviour on the natural substrates

The morphology and size of the structures of the two strains, inoculated on different sterilized substrates, were compared (Rambelli *et al.*, 1991a). While CR1 presents the same features on the different substrates, CA2 proves a strong variability and, in particular, no characters comparable with the type species *C. fulva.*

Vitamins requirement

CR1, not developing on Czapek agar, grows abundantly on this medium only when vitamin complex is added even at the maximum dilution. CA2, developing on Czapek agar, seems not to be influenced in its growth, compared with the control, by the presence of some vitamins in the medium (fig. 2a, b).

Analysis of hyphal compatibility

By growth analysis of the two strains in microcultures and Petri dishes some little morphological differences in the hyphae of the strains are observed. The growth of mycelia of two strains together do not

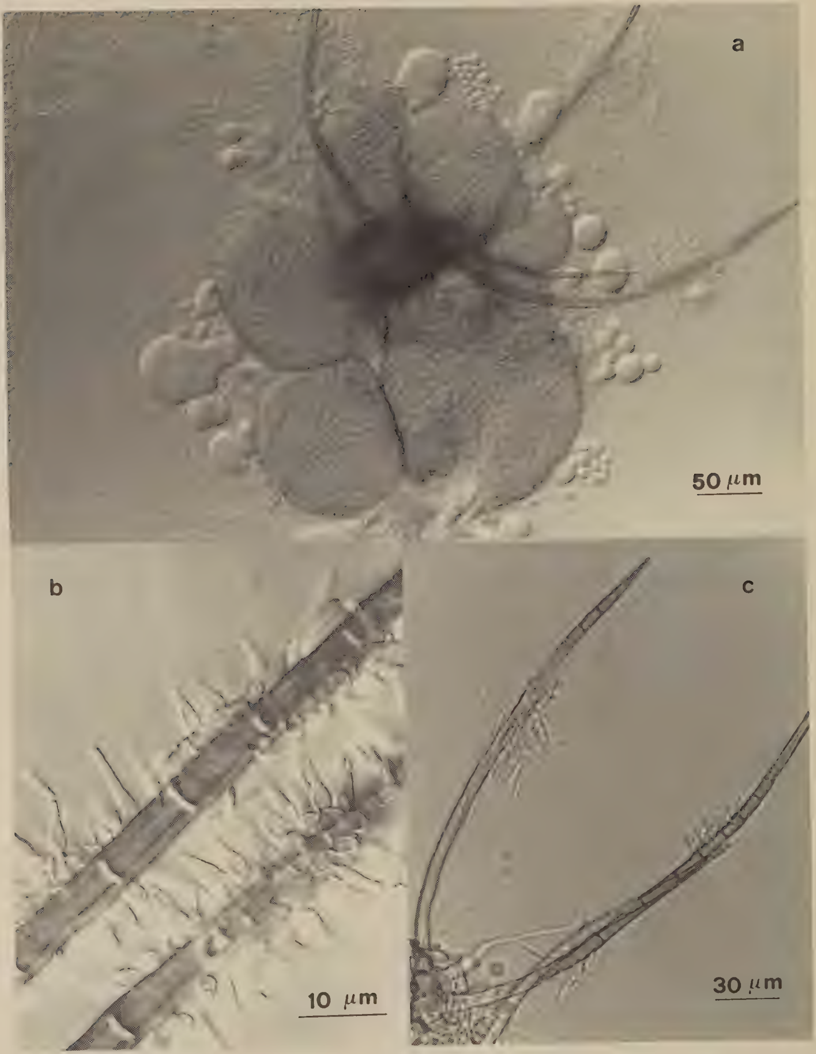
a
50 µm
b
10 µm
c
30 µm

Fig. 1 - *Chaetopsina nimbae*: a, unripe globose perithecium like structures with an anamorph; b, phialidic conidiogenous cells; c, setiform conidiophores.

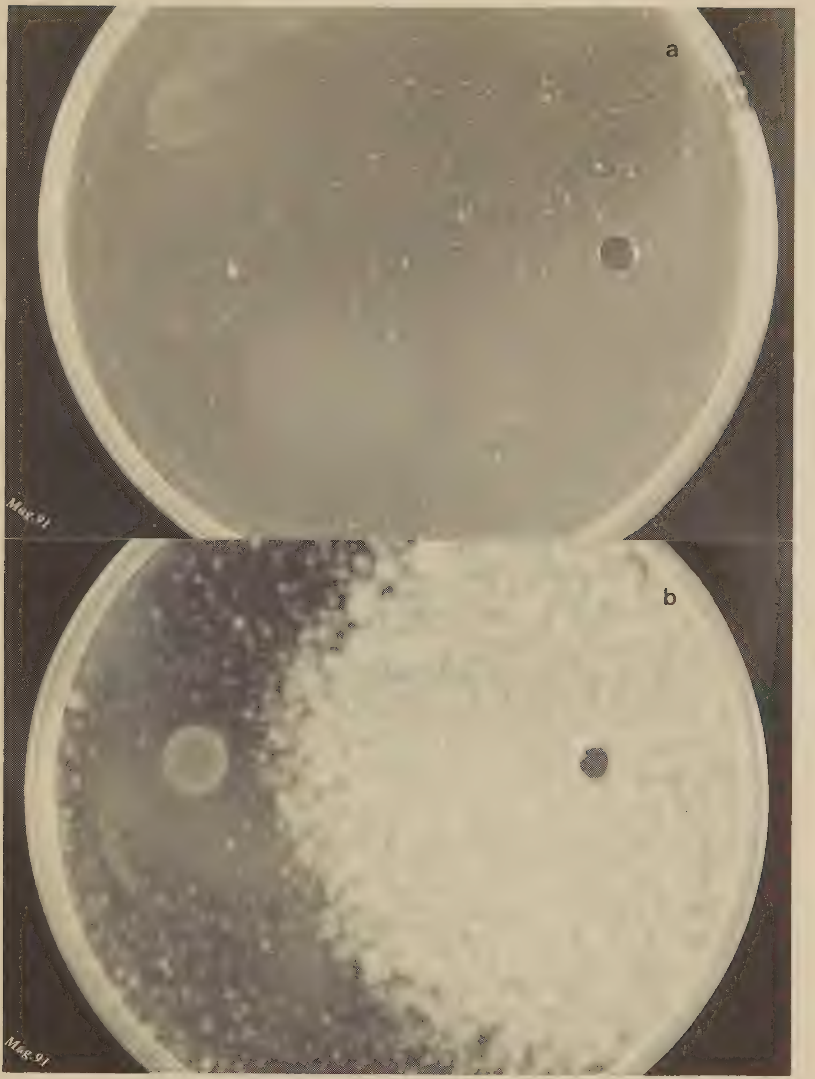

Fig. 2 - a, CA2 strain: limited but uniform development in Czapek not influenced by the presence of vitamins in the medium; b, CR1 strain: influence of a vitamin complex on growth.

present any antagonisms and inhibitions, but no hyphal fusions are observed.

Discussion

Tubaki and Saito (1969) report the finding of *C. fulva* on *Pinus densiflora* Sieb. et Zucc. litter in Japan, but from their description, it seems reasonable to belive that the strain is different from the type species of *C. fulva.* In fact, it differs in conidia and conidiophores dimensions; in conidiophores colour, dark-brown in their strain instead of yellow-red of *C. fulva.* We hadn't the possibility to observe the Tubaki and Saito strain, but, for the above-mentioned characters, it seems very similar to CA2.

In comparison with *C. fulva*, our strain has remarkable differences, mainly in conidia and conidiophore dimensions but also in the colour of fertile structures: chlorine-pale yellow in our *Chaetopsina* and red-yellow in *C. fulva*; in the shape of conidiophores and, with considerable differences, in the colour of the colony. The incompatibility between the mycelia of *C. fulva* (CR1) and our strain (CA2) and the strong diversity of behaviour in vitamin requirements confirm the taxonomic differences.

On the base of all these observations and owing to the absence in the leterature of any description corresponding to CA2, we propose to consider the strain a new species.

Chaetopsina nimbae Rambelli, sp. nov.

Etym.: from Mt. Nimba, where the fungus has been found.

Hyphae pallentes, septatae, leves, protoplasmate granuloso. *Conidiophora* setiformia, erecta, recta vel ad locos conidia producentes modice curvata, septata, crassitunicata, levia, flaventia, pallidiora versus rugosum apicem, protoplasmate homogeneo, 214-392 µm longa et 7.5-13 µm prope basim crassa. *Cellulae conidiogenae* enteroblasticae, monophialidicae, tenuitunicatae, hyalinae, ampulliformes vel lageniformes, copiose productae, 4-5 x 2-3 µm in ramis fertilibus plurimorum ordinum praeditae, *Conidia* hyalina, continua, cylindrica, extremitatibus leniter rotundato, 11-16 x 2-2.5 µm in capitulum mucosum aggregata.

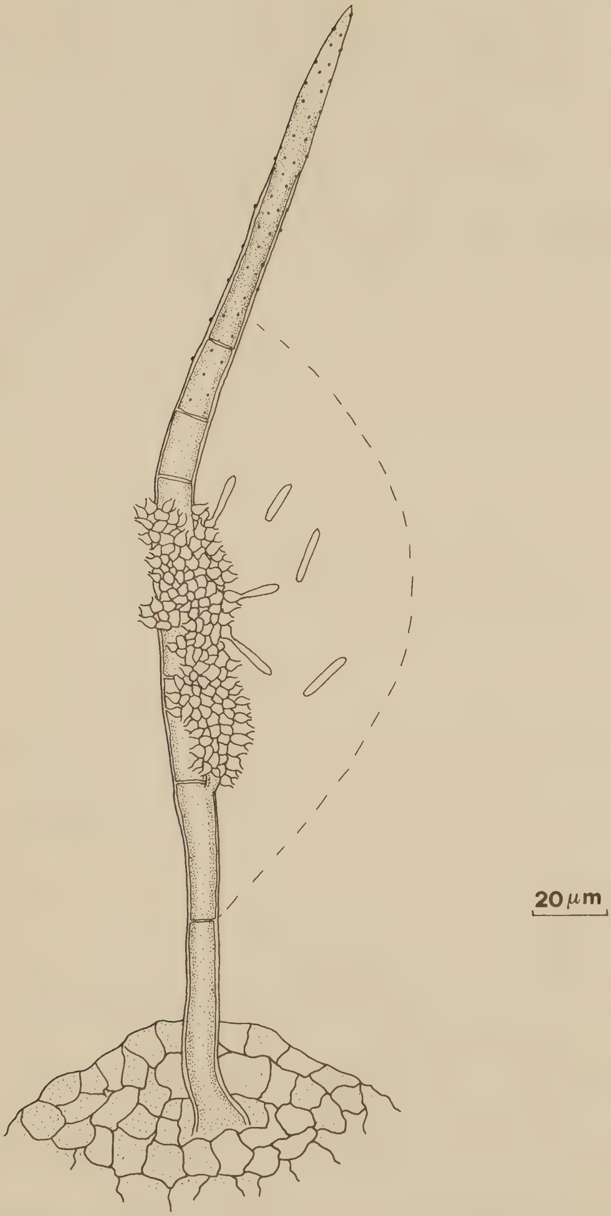

Fig. 3 - Conidiophore arising from a wall of a unripe globose perithecium like structure.

In foliis emortuis *Lophirae alatae* Banks ex Gaertn. Nimba Mountains, Guinea Conacry (SW. Africa), leg. A. Rambelli, Nov. 1989, ROHB 138 A, holotypus.

Hyphae hyaline, septate, with smooth walls, light yellow. *Conidiophores* setiform, slightly curved on fertile side, septate, thick and smooth walled, yellow and paler towards the roughened apex, 214-329 µm long and 7.5-13 µm wide near the base. *Conidiogenous cells* enteroblastic, monophialidic, thin walled, hyaline, ampulliform to lageniform, 4-5 x 2-3 µm, abundantly produced on one up to three (rarely four) branches, originating from the second or the third basal cell of the conidiophore. *Conidia* hyaline, one-celled, rod shaped, with rounded apices, 11-16 x 2-2.5 µm, aggregated in slimy-mucous masses.

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VITAL VERSUS HERBARIUM TAXONOMY:

MORPHOLOGICAL DIFFERENCES BETWEEN LIVING AND DEAD CELLS OF ASCOMYCETES, AND THEIR TAXONOMIC IMPLICATIONS [1]

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- in vivo veritas -

ABSTRACT

Micromorphology of fungal cells as observed under the light microscope differs considerably when comparing living with dead cells. Furthermore, different mounting media in current use may highly influence the appearance of fungal cells, and ontogenetic alterations increase the scope of their variability. Taxonomical work must, however, be based on organs in compatible states and development stages. Arguments are presented for diagnoses based on the morphology of living unaltered cells from freshly collected specimens. Living ascocarp cells are to be studied in their fully hydrated state by mounting in aqueous solutions with a very low concentration of ingredients. Tap or rain water is a suitable mountant. Vital taxonomy provides many additional and often new characters of high taxonomic value which are furthermore often more consistent. These can be observed by easy and rapid methods from the living fungus but become obscure or disappear completely in the herbarium. Different kinds of cytoplasmic inclusions are especially concerned. The development stage of a given organ can be much more precisely ascertained in the vital state. Vitality of single cells can be recognized by their

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[1] Based on a poster (IB-67/2) and a video film given at the Fourth International Mycological Congress held in Regensburg, F. R. G., 28th Aug. - 3rd Sept. 1990 (BARAL, 1990).

osmotic response, by the appearance of their cytoplasm, or through staining *in statu vivo* with basic dyes. Striking alterations during the death of fungal cells are, e.g., shrinkage for about 30-50% of the original volume, or expansion of inner wall layers to about 2-5 times their normal thickness. One new combination is proposed: **Allophylaria nervicola** (Velen.) Baral *comb. nov.*

ZUSAMMENFASSUNG

Die Mikromorphologie pilzlicher Zellen ist bei lichtmikroskopischer Analyse in hohem Maße verändert, wenn lebende mit toten Zellen verglichen werden. Außerdem kann das Aussehen von Pilzzellen sehr stark von der Verwendung verschiedener gebräuchlicher Präpariermedien abhängen. Schließlich erhöhen ontogenetische Veränderungen den Grad der zu beobachtenden Variabilität. Taxonomische Arbeit muß sich jedoch auf Organe in kompatiblen Zuständen und Entwicklungsstadien beziehen. Es wird dringend angeraten, Analysen auf die Morphologie lebender, noch unveränderter Zellen frisch gesammelter Fruchtkörper zu gründen. Lebende Ascocarpzellen müssen im Zustand maximaler Wassersättigung unter Verwendung wässriger Lösungen mit sehr niedriger Konzentration gelöster Stoffe untersucht werden. Leitungs- oder Regenwasser sind hierfür geeignete Präpariermedien. Die Vitaltaxonomie ermöglicht den Gebrauch vieler zusätzlicher und oft neuer Merkmale von taxonomisch hoher Relevanz und oft erhöhter Konstanz. Diese können mit einfachen, zeitsparenden Methoden am lebenden Objekt beobachtet werden; sie sind jedoch im Herbar verwischt oder verschwinden gänzlich. Dies betrifft insbesondere verschiedene Typen von Plasmaeinschlüssen. Das Entwicklungsstadium eines Organs kann im Lebendzustand viel präziser erkannt werden. Die Vitalität von Einzelzellen läßt sich am osmotischen Verhalten, am Aussehen des Zellplasmas oder mithilfe der Vitalfärbung durch basiche Farbstoffe erkennen. Auffällige Veränderungen beim Absterben von Pilzzellen sind z. B. das Schrumpfen um etwa 30-50% vom Ursprungsvolumen, oder die Quellung innerer Zellwandschichten um das ca. 2 bis 5-fache ihrer natürlichen Dicke. Eine neue Kombination wird vorgeschlagen: **Allophylaria nervicola** (Velen.) Baral *comb. nov.*

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1. INTRODUCTION

During my taxonomic studies on Ascomycetes (mainly discomycetes) for some 17 years, I soon noticed that fungal cells mostly show a very different micromorphology under the LM (magnification 600-1500x) when fragments of fruitbodies from the herbarium in tap water mounts were compared with those from freshly collected specimens in the same medium. These alterations were also produced when fresh collections were treated without enough care: during transport to the laboratory by prolonged exposure to a dry atmosphere, by mechanical damage of the fresh ascocarps, or by strong pressure on the coverglass during preparation.

The observed differences between fresh and dried or carelessly treated specimens were, e.g. (FIG. 1 abc→def): (1) dramatic shrinkage of spores, asci and paraphyses; (2) spores clustered at the top of the ascus versus dispersed throughout the (shrunken) ascus; (3) many globose refractive guttules (LBs) within the spores versus several large aggregations or none; (4) refractive bodies within the paraphyses versus "empty" paraphyses.

More detailed investigations using basic dyes for staining the cells *in statu vivo*, as well as osmotic tests, clearly proved that the observed differences originate in the living versus dead state of the cells. Since living fungal cells turned out to offer much more valuable and consistent taxonomic characters (with regard to both cytoplasm *and* cell wall), I early restricted my studies intuitively to the morphology of living cells (except for apical ascus wall structures), a method which I finally called *vital taxonomy* (BARAL, 1989a: 120; 1990). This is in contrast to the currently applied method of Ascomycete taxonomy using the LM, which is mainly based on describing dead dried material preserved in herbaria.

STRUGGER (1949) gave a comprehensive summary of this problem for the field of plant physiology. He emphasized the study of the living cytoplasm (*Lebendzytologie*) which, he was convinced, would undoubtedly attain more importance in the future when compared to the classical method of studying fixed material (*Fixierungszytologie*). According to STRUGGER (1949: 2, 143), differences in the structure and organization of the living cytoplasm must not necessarily produce differences in the morphology of the cell wall. STRUGGER's *Lebendzytologie*, however, scarcely influenced the current methods of micromorphological research on fungi in the following decades. Instead, the new technique of electron microscopy which *imposes the restriction of viewing only dead or rapidly dying material* (READ et al., 1982: 2062) started its rapid development. More and more taxonomic work is carried out using this technique.

During my study on Leotiales, I became convinced that many taxonomic conflicts are due to the prevailing absence of careful studies of living cells. Only a few mycologists have emphasized the advantage of microscopic examination of Ascomycetes *in statu vivo*: BOUDIER (1885: 95; 1886: 141; 1914: 54) layed stress on the fact that he never used dried specimens for his descriptions because these nearly always give incorrect results. He consequently considered dried specimens *un obstacle à toute bonne classification*. LAGARDE (1906: 135ff.) wrote: *Les échantillons secs d'herbier (...) donnent toujours des résultats médiocres et exposent à des erreurs. Les organes délicats des Discomycètes charnus subissent par la dessication des altérations profondes, irrémédiables.* In her study on the ontogeny of ascospore ornamentation in the Pezizales, LE GAL (1947: 78) wrote: *(...) seules les observations vitales pouvaient nous donner des résultats satisfaisants*. Even anatomical studies of apothecia are, according to CORNER (1929: 264), better performed with living cells: *The best method of examining the growth of the hyphae and the origin of the tissues was found to be by means of freehand sections of living material.*

Surprisingly few reports of method-dependent alterations in fungal micromorphology have been published. Instead, taxonomists tend to describe either living or (more frequently) dead elements without taking possible alterations into consideration and rarely give detailed indications of their preparative treatments by specifying these for each given measurement or illustrated organ. GRADDON (1951: 693) wrote: *The following descriptions are drawn from fresh material and spore measurements are taken from spores freely thrown by living specimens and collected on coverglasses*, but he sometimes described dead elements as well without commenting on this fact. This can often be concluded from his drawings which, in the case of living specimens, show spores clustered at the top of the asci, containing globose and symmetrically arranged guttules. Personal communication revealed that others are used to ignore the living cells as "abnormal" and to prefer the dead elements for study.

Often, however, one is unable to recognize the state of the measured and described elements in a given publication. Recently, SPAIN (1990) reported drastic alterations induced by reagents applied to fresh spores of Endogonaceae, stating that *it may not be possible to discern from diagnoses whether alterations took place before or after descriptions were made.* He recommended that diagnoses should be given based on both fresh, untreated and reagent-treated specimens. Likewise, HUHTINEN (1990b) wrote: *At least one of the depicted populations should represent living specimens mounted in water.*

My field of work concentrates on the species of the Leotiales. Therefore, most observations of taxonomical importance concerning vital taxonomy were made on this group. A key to the presently known European species is in preparation. This key will be based, as far as possible, using vital taxonomy, and is hoped to allow a rapid identification of fresh collections.

2. MATERIALS AND METHODS

A Zeiss microscope with bright field and phase optics was used for all observations, with phase 100x/1.25 oil immersion objective, and 12.5x or 15x binoculars. The illustrations were made without the aid of a drawing tube. The depicted specimens originate from the following collections (HB = the authors herbarium, A = Austria, CH = Switzerland, D = F. R. Germany, F = France, L = Luxembourg, S = Spain):

Aleuria aurantia (Pers.) Fuck., 25.XI.87, D-Tübingen-Pfrondorf, on clayey ground, leg. HB, HB 3316 -- **Allophylaria nervicola (Velen.) Baral comb.nov.** [2], 24.X.87, D-Tübingen-Pfrondorf, on petioles and veins of **Acer pseudoplatanus**, leg. HB, HB 3292 -- **Brunnipila clandestina** (Bull. ex Mérat : Fr.) Baral in Baral & Kriegl-st., 30.V.88, D-Tübingen-Pfrondorf, on canes of **Rubus idaeus**, leg. HB, HB 3425 -- **Ciboria caucus** (Rebent.) Fuck., 16.III.88, D-Kirchheim-Bonlanden, Breuningsweiler, on male catkins of **Alnus glutinosa**, leg. J. Haedecke -- **Cistella deflexa** (Gradd.) Raitv., 3.XI.85 D-Tübingen-Lustnau, on leaves of **Populus ? canadensis**, leg. HB, HB 2951 -- **Conchatium fraxinophilum** Svrček, 24.X.87, D-Tübingen-Pfrondorf, on petioles of **Fraxinus excelsior**, leg. HB, HB 3293a -- **Discina ancilis** (Pers.) Sacc., 26.III.88, D-Tübingen-Pfrondorf, on bark of **Picea abies** trunk, leg. HB -- **Hymenoscyphus** cf. **sazavae** (Vel.) Svrček, ≈27.IX.87, F-Gérardmer, on wood and cone of **Picea abies**, leg. J. Deny, HB 3277 -- **Hymenoscyphus scutula** (Pers. : Fr.) Phill., 24.X.87, D-Tübingen-Pfrondorf, on stems of **Tanacetum vulgare**, leg. HB, HB 3290 -- **Hymenoscyphus consobrinus** (Boud.) Hengstm., 24.VIII. 87, Tübingen-Dettenhausen, on stems of **Anthemis nobilis**, leg. G. Haupter -- **Lachnum controversum** (Cke.) Rehm, 24.VII.87, D-Tübingen, on culms and leaves of **Phragmites communis**, leg. HB, HB 3229 -- **Lasiobelonium corticale** (Pers. : Fr.) Raitv., 15.V.88, L-Tuntange-Hollenfels, on bark of **Populus tremula** stump, leg. C. Besch, R. Swart-Velthuyzen & HB, HB 3386 -- **Lasiobelonium variegatum** (Fuck.) Sacc., 28.VII.88, CH-Schaffhausen-Thayngen, on bark of **Salix** ≈ **cinerea** branch, leg. HB & G. Marson, HB 3496 -- **Lecanora conizaeoides** Nyl. ex Crombie, 13.VII.88, D-Tübingen-Pfrondorf, on wood of ? **Picea abies** fence, leg. HB, HB 3459 -- **Melastiza chateri** (W.G. Smith) Boud., 20.XI.87, CH-Schaffhausen-Thayngen, on clayey ground, leg. HB & P. Blank, HB 3317 -- **Mniaecia jungermanniae** (Nees ex Fr.) Boud., 12.II.88, D-Tübingen-Pfrondorf, on **Cephalozia bicuspidata**, leg. HB, HB 3336b -- **Mollisia** spec., 20.VI.88, D-Tübingen-Pfrondorf, on wood of **Quercus** trunk, leg. HB, HB 3441 -- **Nimbomollisia eriophori** (Kirchn.) Nannf., 21.V.88, CH-Zug-Unterägeri, on culms of **Juncus effusus**, leg. J. & L. Rothenbühler -- **Nimbomollisia melatephroides** (Rehm) Nannf., 27.VII.88, CH-Zug-Unterägeri, on leaves & culms of **Molinia coerulea**, leg. HB, P. Blank, J. & L. Rothenbühler, HB 3483 -- **Orbilia auricolor** Blox. ex Berk., 21.VIII.88, D-Tübingen-Pfrondorf, on stems of **Oenothera biennis**, leg. HB, HB 3527 -- **Orbilia delicatula** (Karst.) Karst., 22.VIII.88, D-Tübingen-Pfrondorf, on wood of **Acer pseudoplatanus** stump, leg. HB, HB 3529 -- **Orbilia** ? **rosella** (Rehm) Sacc., 10.VIII.88, D-Tübingen-Pfrondorf, on stem of **Melilotus albus**, leg. HB, HB 3518a -- **Orbilia sarraziniana** Boud., 14.V.88, L-Beaufort, on wood of **Fagus sylvatica** twig, leg. HB -- **Orbilia** spec., 10.VIII.88, D-Tübingen-Pfrondorf, on stem of **Melilotus albus**, leg. HB, HB 3518b -- **Pezicula cinnamomea** (DC. : Pers.) Sacc., 23.VII.87, D-Tübingen-Pfrondorf, on bark of **Carpinus betulus** twig, leg. HB, HB 3239 -- **Pezicula livida** (Berk. & Br.) Rehm, 27.VIII.86 D-Tübingen-Pfrondorf, on bark of **Pinus sylvestris** branch, leg. HB -- **Peziza** ? **fimeti** (Fuck.) Seaver, ≈30.V. 88, D-Tübingen-Pfrondorf, on straw and horse dung, leg. P. Zinth & HB -- **Phaeohelotium geogenum** (Cke.) Svrček & Matheis, 18.X.89 A-Grünburg-Steinbach, on leaf & twigs of ? **Quercus**, and apple pressings residue, leg. H. Helm, HB 3907 -- **Polydesmia pruinosa** (Jerdon in Berk. & Br.) Boud., 14.VI.87, D-Tübingen-Pfrondorf, on **Hypoxylon** spec., leg. HB -- **Pyrenopeziza petiolaris** (Alb. & Schw. : Fr.) Nannf., 26.III.88, D-Tübingen-Pfrondorf, on petioles of **Acer pseudoplatanus**, leg. HB -- **Rutstroemia elatina** (Alb. & Schw. : Fr.) Rehm, 15.III.1986 D-Tübingen-Pfrondorf, on bark of **Abies alba** twigs, leg. HB -- **Sarcoscypha austriaca** (Beck ex Sacc.) Boud., 20.V.79, D-Hinterzarten, Feldberg, on wood of **Acer pseudoplatanus** branches, leg. HB, P. & D. Laber, HB 2537 (neotype) -- **S. coccinea** (Scop. : Fr.) Lamb., 12.III.79, D-Karlsruhe-Hambrücken, on wood of **Ulmus carpinifolia** branches, leg. K.H. Waßmuth & HB, HB 2460 (neotype) -- **S. jurana** (Boud.) Baral, 5.III.79, D-Hayingen-Lauterach, on bark of **Tilia platyphyllos** branches, leg. P. Zinth & HB, HB 2461 -- **S. macaronesica** Baral & Korf in Baral, 20.I.82, S-Gomera-Vallehermoso, on wood of ? Lauraceae twigs, leg. P. Zinth, HB 2610 (holotype) -- **Scutellinia scutellata** (L. ex St. Amans) Lamb., (collection of unknown provenance), leg. HB -- **Trichopezizella nidulus** (Fr.) Raitv. s.l., 11.V.88, F-Gérardmer, on stems of **Ranunculus aconitifolius**, leg. J. Deny, HB 3384 -- **Tubeufia cerea** (Berk. & Curt.) Booth, 17.VI.86 D-Murrhardt, on **Diatrype stigma**, leg. L. Krieglsteiner, HB 3039 -- **Tubeufia paludosa** (Crouan & H. Crouan) Rossm., 7.VIII.88, D-Tübingen, on culm of **Phragmites communis**, leg. HB, HB 3507b -- **Tympanis alnea** (Pers.) Fr., 25.V.87, CH-Schaffhausen-Thayngen, on bark of **Prunus avium** twig, leg. P. Blank, HB 3187 -- **Verpa digitaliformis** Pers., 8.V.91 D-Tübingen-Bebenhausen, under **Petasites**, leg. HB, HB 4411 -- **Xanthoria parietina** (L.) Th.

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[2]) Basionym: **Helotium nervicolum** Velenovský, Monogr. Discom. Bohemiae 1934: 206 (≡ **Conchatium nervicolum** (Velen.) Svrček, = **Allophylaria subhyalina** forma b in BARAL & KRIEGLSTEINER 1985: 94)

Fr., 7.VI.86 D-Tübingen-Pfrondorf, on bark of **Malus domestica** trunk, leg. HB, HB 3036.

Abbreviations:

✻ = living hydrated state *(in statu vivo et udo/umido)*

† = dead hydrated state *(in statu emortuo et udo/umido)*

LM = light microscope
TEM / SEM = transmission / scanning electron microscope

H_2O = tap water (of medium hardness)
IKI = Lugol's solution (1% [3] I_2, 3% KI in water)
MLZ = Melzer's reagent (1.2% I_2, 3.6% KI, 48% chloral hydrate in water)
CRB = Brilliant cresyl blue (0.1-1% in tap water, not distilled water)
CRB_A = alkalinized CRB: a small drop of 0.5% KOH or strong NH_4OH is added to a CRB mount
KOH = potassium hydroxide (0.5-10% in water)
CB = cotton blue (0.5% in lactophenol, i.e. equal proportions of phenol, glycerol, lactic acid and water)
CZB = chlorazol black (1% in glycerol buffer)

cytoplasmic structures:

LB = lipid body
SCB = KOH-soluble cytoplasmic body
WB = Woronin body
N/NO = nucleus/nucleolus

vacuolar structures:

VB = refractive vacuolar body
V = non-refractive vacuole
MC = metachromatic corpuscle

DBB = de Bary bubble

3. HOW TO RECOGNIZE LIVING FUNGAL CELLS

Vitality of single cells is defined according to STRUGGER (1949: 170f.) by intact (semipermeable) plasma membranes. Viable cells therefore show turgescence when mounted in hypo-osmotic media (with an osmosity lower than that of the cell sap). Current tests, such as for germination ability or metabolic activity, are here of minor value because (1) vitality has to be proved for a single cell, and (2) many types of cells (e.g. asci) are unable to germinate.

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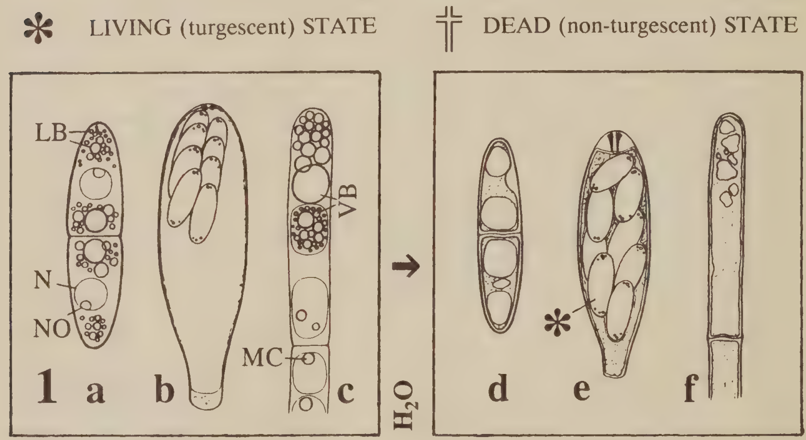
[3] All values in this paper given in % refer to w/w = weight of solute per weight of solution (solvent + solute).

Vitality can easily be recognized under the LM (oil immersion) by the following tests: 1. Cell turgor: adding strongly hyperosmotic media to the water mount provokes shrinkage (not collapse!) of living but not of dead cells (in the case of elastic cell walls). Reversible plasmolysis is also a reliable proof for vitality, occurring especially in vegetative cells. These tests require that the cell wall is freely permeable for the reagent, otherwise both living and dead cells may collapse. In water mounts of multi-celled organs, the septum is strongly curved towards the dead cell if the adjacent cell is intact (FIGs. 2d, 3). Slight constrictions at the septa are typical for living thin-walled cells (FIGs. 2 a-c, 7a, 13a).


✻ LIVING (turgescent) STATE

┼ DEAD (non-turgescent) STATE

FIG. 1. How to distinguish living from dead cells. Hymenial elements (spore, ascus, paraphysis) of fictitious species of Leotiales in the living (**abc**) versus dead state (**def**). The dead ascus contains still living spores.

2. Structure of the cytoplasm: in water mounts, living fungal tissue shows high transparency and contrast while dead cytoplasm is detached from the cell wall and is usually much more refractive due to dehydration, therefore opaque (FIGs. 1 d,f; 2 d,f; 3; 12b). Cytoplasmic inclusions show aesthetic and symmetrical patterns when intact but irregular distortion or optical absence when dead.

3. Staining *in statu vivo*: basic (alkaline) dyes added to water mounts accumulate (within seconds or minutes) selectively inside intact vacuoles of the living cell without damage to the plasma membranes, either homogeneous (FIG. 30, *VB*) or by forming globose bodies as a result of flocculation of (poly-)phosphates (volu-

tin bodies, metachromatic corpuscles/granules, FIGs. 4, 30, *MC*). The living cytoplasm is thereby not stained. Yet, in dead cells with destroyed plasma membranes (loss of semipermeability), the cytoplasm is deeply stained within seconds while no accumulation and MC-formation occurs in the vacuoles (FIG. 21b; GUILLERMOND, 1941: 129ff.; STRUGGER, 1949: 126ff.; HEINEMANN, 1956: 36ff.; BANCHER & HÖFLER, 1959: 150ff.; HOHL, 1987: 17; ROMEIS, 1989: 27, 302ff., *Trypanblau-Ausschlusstest*). Staining of the vacuoles with basic dyes is *essentially a phenomenon of the living cell* (GUILLERMOND, 1941: 145) and the most valuable test for vitality (BANCHER & HÖFLER, 1959: 153).[4]

The contrast between the unstained (living) and stained (dead) cytoplasm is usually striking and corresponds to fig. 119 in ERB & MATHEIS (1983) showing both living and dead cells in multi-celled spores of **Ophiobolus acuminatus** stained by phloxine. (Similar to basic dyes, phloxine is only able to stain the dead cytoplasm.) Yet, cell contents rich in lipids or vacuoles but poor in cytoplasm are less distinctly stained in the dead state, and thick walls of spores were found to be impermeable to basic dyes in either state.

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[4]) Overstaining must be avoided since concentrations above approx. 0.5% may be lethal. Aqueous CRB solution, slightly alkalinized (CRB_A) in case the stain does not readily penetrate through the plasma membranes, gives good results: blue-violet for MCs, blue-green to violet for homogeneous staining (see CHADEFAUD, 1938: 116; GUILLERMOND, 1941: 143; LE GAL, 1947: 78). The CRB (0.1-1%) is added to the margin of the water mount resulting in a CRB solution of about 0.05-0.5%. The KOH accelerates the process of staining the vacuoles because only undissociated molecules of CRB (which do not exist at a pH lower than 7) pass through the plasma membranes.

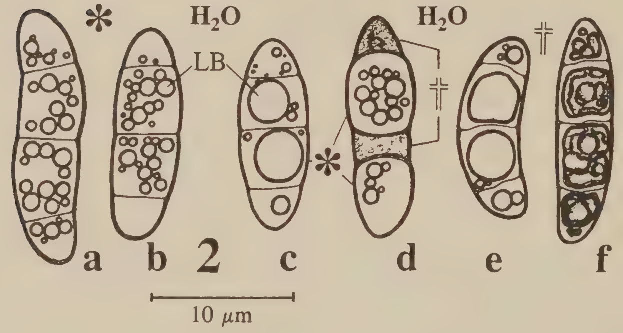
Non-alkalinized CRB is also used for diagnostic violet stains of wall layers in Basidiomycetes (SINGER, 1986: 89). I recommend CRB as a standard reagent for Ascomycete taxonomy because it allows the recognition of mucilage on hyphae or spores by staining deep violet (see chapter 5.c.) while resinous exudates stain deep turquoise-blue.

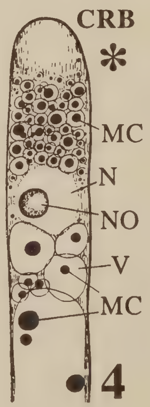
I found the aqueous solution (in tap water) to be stable for years; yet, CLÉMENÇON (1972) added several ingredients because he found CRB in water to precipitate within a few days. CRB is not considered carcinogenic by ERB & MATHEIS (1983: 28). Other basic dyes dissolved in tap water have been tested in comparison: toluidine blue, used by MOORE (1965: 26) and MATHEIS (1975: 160) as a stain for mucilage, gives results comparable to CRB showing striking turquoise-blue and red-violet metachromatic colors. However, CRB gave more reliable results because it is blue in tap water while toluidine blue is violet in that medium. Contrary to toluidine blue, the color of CRB depends furthermore on the pH (turquoise-blue in acetic acid, red-violet in KOH). Contrary to CRB, toluidine blue did not easily penetrate into the living cell. Neutral red and cotton blue may also be used but do not show striking metachromatic color changes.

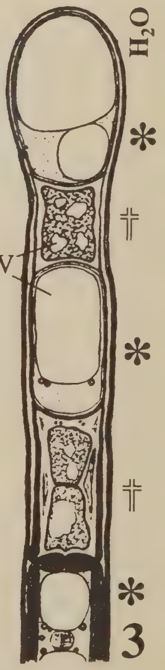
4. HOW TO AVOID MORPHOLOGICAL ALTERATIONS OF LIVING FUNGAL CELLS DURING MICROSCOPIC EXAMINATION

4.a. Mounting medium

STRUGGER (1949: 4) recommended mounting cells of living land plants in *aqua bidest*. Similar to plants, Ascomycetes, developing under natural conditions, are usually exposed to rain water (i.e. approximately distilled water). Drought-







FIGs. 2-4. How to distinguish living from dead cells.
FIGs. 2-3. Two examples of living versus dead cells occurring partly in one organ. Note (1) shape of thin-walled septa (straight between living cells, curved between a living and a dead cell, more or less wrinkled between dead cells), (2) transparency of the living cytoplasm, (3) coalescence of LBs (in FIG. 2c already in the living cells), (4) detachment of the cytoplasm from the cell wall, (5) dramatic loss of volume of the dead cell especially if situated between living cells (FIG. 2d). **FIG. 2.** ascospores of **Polydesmia pruinosa**, **FIG. 3.** hair tip of **Trichopezizella nidulus.** 2000x.
FIG. 4. Upper region of a living immature ascus with fusion nucleus and vacuoles containing MCs which are typical for living cells (stained with neutral red or CRB; from CHADEFAUD, 1938: fig. 2).

tolerant species in particular, which dry out completely during dry weather, rapidly absorb water during rainfall and are most favourably collected immediately afterwards. Aquatic species develop below the water level in rivers and lakes. Rain or tap water is therefore the natural preparation medium for these fungi.

Mounting in media with a high osmosity induces severe shrinkage, especially of asci (see chapter 5.a.). A test with artificial sea water (3.4% sodium chloride [NaCl]) on some species of Leotiales and Lecanorales revealed shrinkage in ascus width for 2-12%. Accordingly, concentrations upto 0.3% NaCl produce shrinkage for max. about 1% and are therefore compatible to distilled water for the purpose of taxonomy. Tap water has an osmosity of roughly 0.0003 to 0.006% NaCl. Hence, it is safe to say that mounting fruit-bodies of Ascomycetes in tap water of any hardness corresponds to the natural situation of these fungi.

Staining *in statu vivo* with basic dyes or with IKI is only lethal after a considerable period of time. However, mounting in currently used media, with either very high (alkaline) or low (acid) pH or other lethal properties, such as MLZ, CB, glycerol buffer (= *L4*), Hoyer's fluid, lactic acid, 2-10% KOH, kills most types of fungal cells within seconds (LINDER, 1929; BARER et al., 1953: 720; HUHTINEN, 1985: 18; BARAL, 1987a: 409 and unpublished data). CLÉMENÇON (1972: 49) worked only with lethal mountants and did not even mention water as a possible medium. The lethal effect of these mountants should be clear but are actually not well-known. Workers are indeed surprised when accidentally encountering it: e.g., LUARD (1983: 529) noted that CB had an *unexpected effect on the appearance of* ***Chrysosporium fastidiosum*** causing a *dramatic contraction of the cytoplasm.*

These mountants have been introduced for the study of herbarium specimens in order to obtain transparency of the cytoplasm, to dissolve trapped air on imperfectly wetted hyphae, to inflate collapsed cells, to avoid movement of floating spores, and to avoid desiccation of the mount during microscopic study (see FLEMING & SMITH, 1944: 17; BARAL, 1987: 408f.). In order to get compatible results, these mountants are often also used for fresh specimens. This led CLÉMENÇON (1972, *L4*) to employ lower concentrations (20% glycerol, ≡ 8.5% NaCl[5]) in order to avoid the collapse of living cells. In my experience, mature spores with rigid walls, e.g. in Pezizales and Xylariales, often survive some hours in media such as MLZ, thus killing by heating of the slides is necessary in order to obtain results compatible with the dead specimen.

Some mycologists try to avoid inflation of fungal cells to an "unnatural" oversize by employing "isotonic media", e.g. 1% glucose (≡ 0.17% NaCl) or 0.85% NaCl (CHADEFAUD, 1938: 116; BRUMMELEN, 1967: 18; ERB & MATHEIS, 1983: 13, 15). The glucose medium is, however, strongly hypo-osmotic and thus gives results corresponding to tap water mounts. H. CLÉMENÇON (in litt. 20.7.87) believed that the physiological state of fungal cells is usually characterized by a low turgor pressure clearly distinct from the state of full hydration and maximum tugor which is obtained in mounts of distilled or tap water. Since the osmotic pressure of fungal cells strongly varies among species and even organs, each case would then need its special iso-osmotic mountant. The following test proves, however, that maximum turgor and hydration is the natural state for full metabolic activity in ascocarp cells of discomycetes: I compared mounts of fresh ascocarps of several species in tap water with those made instead in oil, e.g. immersion oil (or paraffin oil according to STRUGGER, 1949: 5). The oil prevents a possible uptake of further external water during preparation. No difference in size and appearance of the cells and their contents could be observed. This should hold true for all fungal structures which are naturally exposed to rain water. Cells having a cell wall do not need an iso-osmotic medium: their physiological medium is, in these cases, close to distilled water, i.e. strongly hypo-osmotic.

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[5]) The given concentration of NaCl solution has the same osmotic pressure (osmosity) as the mentioned solution. An osmosity of 1 g-mol/l = 5.6% NaCl is equivalent to 6 x 10^{23} ions per litre

I therefore use water as a standard medium for obtaining compatible measurements of living fungal cells. Likewise, MAIRE (1926: 44), for example, wrote: *Les dimensions des spores doivent être mesurées autant que possible sur des spores fraiches examinées dans l'eau*, and SPAIN (1990: 71) wrote: *Arguments are presented for diagnoses based on the morphology of fresh spores suspended in water.*

Osmotolerant hyphae, able to grow in media with a high concentration of glucose, and especially marine fungi might represent an exception. LUARD (1983: 533) therefore measured the hyphal diameter of osmotolerant species by mounting in *slightly hyperosmotic KCl*. A similar case is represented by the ascospores while still inside the living ascus: the spores are embedded in the vacuole sap with a high osmosity, and increase considerably in size within about 1/2 minute following discharge into water.

In order to obtain compatible measurements, I recommend to avoid measuring ascospores within living asci. Probably all fungi can be observed and measured in the standard mountant tap water without bursting of the hyphae. This view is supported by the report of JONES et al. (1991) who found fungal cultures to survive several years in distilled water in small phials.

4.b. Preparative techniques in vital taxonomy

The specimens chosen for microscopic examination must be in the fully hydrated living state. Species growing in permanently humid places are usually sensible to drought and must be transported to the laboratory without the loss of intracellular water. Desiccated ascocarps of drought-tolerant species can be rehydrated by spraying with water several minutes prior to preparation. Fragments of the fruit-bodies are gently (!) squeezed under the coverglass. Freehand sections (about 30-100 μm thick, depending upon the diameter of the cells) through the fully hydrated living fruit-body made with a razor blade are superior, allowing excellent study of ascocarp textures (BOUDIER, 1886: 136; CORNER, l.c.), while dead hydrated tissue is difficult to cut freehand because of its flabbiness. Heating or any stronger pressure must be avoided. Very often a certain number of spores, asci, and vegetative cells are already dead prior to preparation (FIGs. 2d, 3), or they die when cut by the razor blade. These cells must be disregarded for the purpose of vital taxonomy.

5. ALTERATIONS IN THE CELL WALL

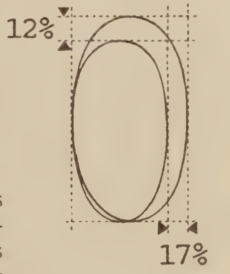
5.a. Cell size: the shrinking effect

As hydrated fungal cells die, they lose turgor and often show a strong decrease in size (without collapsing) due to elasticity of the cell wall and loss of water mainly from the vacuoles. Irreversible shrinkage is induced by lethal substances such as, e.g., 50% chloral hydrate, 1-5% KOH, or simply by mechanical pressure (FIGs. 2, 3, 6, 8, 9, 10, 12, 13, 14, 21, 22, 33, 34, 35), which destroy the semipermeable properties of the plasma membranes. Both length and width are not infrequently reduced for about 10-20%, with the cell volume (including the cell wall) for about 30-50% (TAB. 1). Such variation in measurements is very often employed for differentiation among species! A linear shrinkage in width for about 30-57% was observed in the asci of species of **Lecanora** (FIG. 9), **Xylaria** and **Lasiosphaeria**.

HUHTINEN (1985: 18) wrote: *In numerous taxa of both the Helotiales and Pezizales, I have observed that the mountants commonly in use have a shrinking effect. When dried material is revived with Melzer's reagent or lactic acid, the sections do not always regain their original dimensions. This can be concluded from the results of adding these mountants to natural or water mounts of fresh apothecia. Shrinkage of 5-15% takes place immediately, due to a loss of turgor in the cells.*

decrease in %	ASCI			SPORES		
	length	width	volume	length	width	volume
Mn. jung.	18.5-20.3	17.8-21.7	46-51	5.7- 8.3	13.9-21.5	30-44
Ci. caucus	14.9-19.7	18.7-22.9	44-51	12.1-14.0	20.8-24.6	45-51
Ru. elat.	10.6-17.4	17.2-23.8	40-52	12.1-18.2	13.3-16.7	34-42
Pe. amenti	13.1-20.8	15.1-25.6	37-56	9.8-13.9	7.5- 9.8	24-29

TAB. 1. Irreversible shrinkage in Leotiales (tap water versus MLZ). **Mniaecia jungermanniae, Ciboria caucus, Rutstroemia elatina, Pezizella amenti.** 4 asci and 4 spores from each species were measured in the living state and after MLZ was added by direct visual monitoring of shrinkage. (Care must be taken in dead spores not to measure the plasma body only).



mean
linear shrinkage
of spores

BECKETT et al. (1984: 93) reported severe dimensional changes during preparative procedures for the SEM: *Although it is logical to expect biological specimens which normally have high water contents to shrink when dried (...), few published results adequately account for this.*

The following literature also discusses the shrinking effect for fungal cells: DE BARY (1887: fig. 43, see FIG. 6), LAGARDE (1906: 135), MAIRE (1926: 44f.), STEINER (1957: 249), HERTEL (1967: 3, 13% linear shrinkage in KOH vs. H_2O), DRING (1971 [in LUARD 1983: 529]), HEIN (1976: 16, about 15% linear shrinkage in CB vs. H_2O), DÖBBELER (1984: 206), BARAL (1987a: 409; 1987b: 121; 1989a: 120; 1989b: 222), HUHTINEN (1990a: 64, 68, shrinkage in width ca. 15%, CB or MLZ vs. *in statu vivo*, H_2O).

The percentage of linear shrinkage during the death of the cells strongly depends upon the taxon, cell type, and cell axis (TAB. 1), but also upon the mountant in which the dead cells are measured (HUHTINEN, l.c.). Furthermore, rehydrating dead cells may result in damaged profiles: e.g., ascus width shows higher variation due to (1) strong pressure on the coverglass which may flatten dead asci, and (2) irregularly arranged spores which swell out the ascus wall (FIG. 9b). Hairs of **Brunnipila** (Hyaloscyphaceae) collapse in dehydrating reagents: their apparent width depends on the angle at which they are lying and can therefore vary from about 1 to 7 μm. The width of the hydrated living hair is about 3-5 μm.

KOH is commonly considered an agent which increases the volume of fungal cells, especially of spores (e.g. HEINEMANN & RAMELOO, 1985), or restores dried plant cells to their "original size" (e.g. CUNNINGHAM, 1969). Such a swelling effect is mainly observed when KOH mounts are compared with mounts of dead cells in water, CB, MLZ etc. When applied to water mounts of living fungal cells, however, KOH often provokes dramatic shrinkage, especially with asci.

On the other hand, living mature spores which pass into the germination phase show a considerable increase in size in many species, partly due to synthesis of new cellular wall material (GARRAWAY & EVANS, 1984: 221). Therefore, even in the dead, shrunken state with a turgor nearly zero this increase in size is obvious. In other species the spores do not change their dimensions during germination. Consequently, measurements which do not indicate (1) the state (living or dead) of the measured cell, (2) the mounting medium, (3) the preparative treatment (heating, mechanical pressure), and (4) the development stage of the cell, are of minor taxonomic value (see also HUHTINEN, 1990a; b).

Decrease of the cell volume with the decrease of the hydrostatic pressure (turgor pressure) is a well-known phenomenon in plant and animal cells and tissue (DAINTY, 1976). The elastic modulus of the cell wall controls the rate of swelling or shrinking: cells with rigid walls do not shrink noticeably if the maximum turgor pressure is brought down to about zero; their elastic modulus is high. Highly elastic cell walls, however, have a very low elastic modulus and the cells shrink considerably in this case. Furthermore, cells shrink to a higher extent if the maximum turgor pressure is rather high, e.g. in mature asci.

It appears therefore incredible that, e.g., CUNNINGHAM (1972) wrote the following incorrect statements about a mountant containing 67% chloral hydrate: *AH* [6] *does not distort spore measurements*, and: *AH sometimes causes slight temporary plasmolysis of certain fresh fungi but normal turgor is totally restored almost always within a few minutes*! CUNNINGHAM misapplied the term *turgor* to cells in a dead, non-collapsed state, their walls showing an even, non-shriveled outline but a very low tension. Likewise, LINDER (1929) and FLEMING & SMITH (1944: 17) wrote that lactophenol *immediately restores the turgor* and *rarely causes either swelling or shrinkage*.

Shrinkage of asci immediately after spore discharge is a well-known phenomenon (FIGs. 23-25; BULLER, 1931: 247: *an ascus reduces its volume to about one half on exploding*; INGOLD, 1986: fig. 1). However, shrinkage to a comparable extent during the death of the mature ascus before *the spores are release*d (FIG. 8 a→b, 9 a→b, 10 a→b) was very rarely reported (e.g. by DE BARY, see FIG. 6) though generally occurring. Shrinkage of asci without spore liberation may also be obtained reversibly without killing by using, e.g., 1 M (= 30%) saccharose (≡ 4.4% NaCl) (INGOLD, 1953: 17, fig. 8). With saccharose solutions higher than about 45% (≡ 9% NaCl) I was able to shrink the asci of **Lecanora conizaeoides** in width from 20-21.5 μm (in tap water) to 12-13 μm (i.e., to an extent close to FIG. 9b), and to reverse these asci to their original size and shape by replacing the saccharose solution with water.

Unawareness of shrinkage has resulted in numerous conflicts and misinterpretations. E.g., KORF (1951) found roughly 25% lower measurements of hairs, asci, spores, and paraphyses in some 20 years old type material of two species compared with the original description given by GRELET. Since GRELET usually studied living cells (which can be concluded from his drawings), following the tradition of BOUDIER, the discrepancy discovered by KORF is readily explained by the shrinking effect. KORF, however, concluded that GRELET's measurements were incorrect, *presumably because of an error in the microscope calibration*, and therefore multiplied GRELET's measurements by an assumed error factor of 0.75. Likewise, authors have found BOUDIER's measurements (which he gave in the text) to be usually too high when compared with their own measurements. MAIRE (1926: 47) referred this discrepancy to an error in the construction of BOUDIER's measuring scale, and recommended the subtraction of one-tenth from BOUDIER's values. Clearly, the shrinking effect is at least one of the true reasons for BOUDIER's larger measurements. Indeed, the magnification of *820x* indicated by BOUDIER on his plates *after 1885* is considered by v. BRUMMELEN (1969; and also by me) to be correct while plates *before 1885* are *approx. 840x* instead of "340x" as BOUDIER indicated (BRUMMELEN, l.c.). The values given in BOUDIER's texts after 1885 are, however, highly erroneous in some cases.

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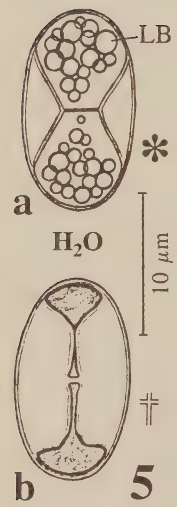
[6]) AH = Andre's modification of Hoyer's fluid: arabic gum 15g, chloral hydrate 100g, glycerol 10g, water 25ml

Some striking effects:

1. Spore arrangement: spores conspicuously change their arrangement during the death of the mature ascus due to excessive loss ot water from the large vacuole of the ascus. This is of taxonomic importance since the arrangement of spores in the asci is very often mentioned in species descriptions. Three phenomena may be observed:

(1) The spores move towards the base of the ascus, thus the *pars sporifera* increases considerably in length (FIG. 8, **Mniaecia**, from 67 to 135 µm; FIG. 9, **Lecanora**, from 26.5 to 38.5 µm). Strictly biseriate spores thereby often become totally (or only in the lower part) uniseriate (FIG. 8).



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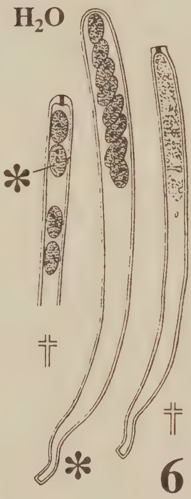

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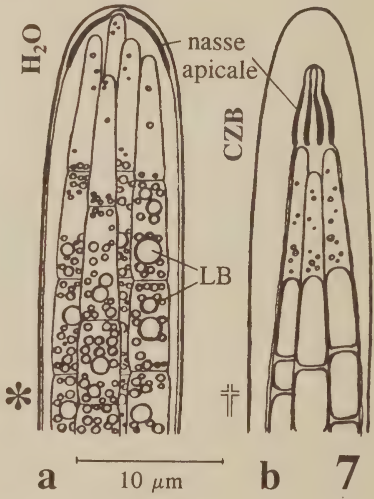

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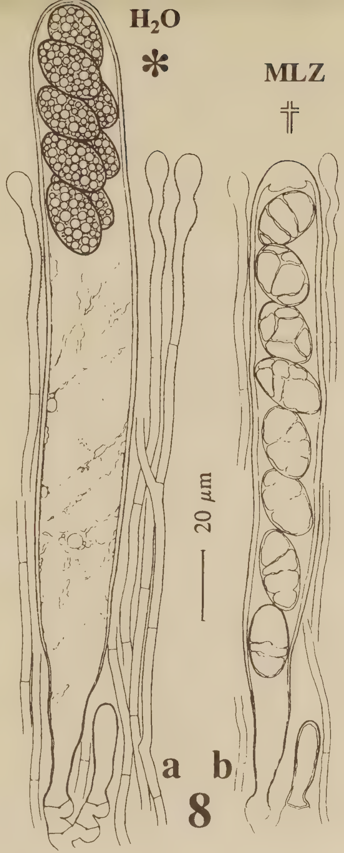
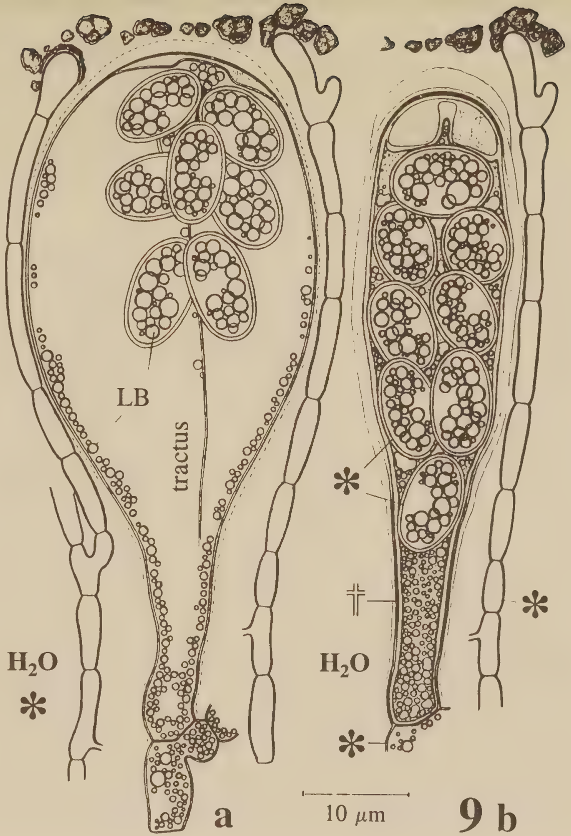
FIG. 5. Expanding wall phenomenon in the ascospores of **Xanthoria parietina**. Note coalescence of single LBs. 2000x.

FIGs. 6-10. Micromorphological alterations of asci (FIGs. 7-10 show one ascus before and few minutes after killing). Note (1) shrinkage of asci and retraction below the tips of paraphyses, (2) loss of most of the vacuole sap, (3) expansion of apical wall layers, (4) movement of spores towards the base of asci. FIG. 9a might be the first published figure of a living Lecanorales ascus! **FIG. 6. Sclerotinia sclerotiorum** (from DE BARY, 1887: fig. 43), **FIG. 7. Tubeufia cerea**, (2000x), **FIG. 8. Mniaecia jungermanniae** (500x), **FIG. 9. Lecanora conizaeoides** (1500x), **FIG. 10. Tympanis alnea** (500x).


H$_2$O
*
MLZ
†
20 μm
a
b

8


LB
tractus
H$_2$O
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H$_2$O
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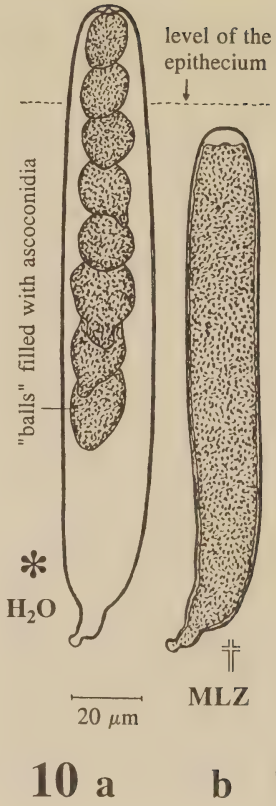
9


level of the epithecium
"balls" filled with ascoconidia
*
H$_2$O
†
MLZ
20 μm
a
b

10

(2) Filiform spores lying as straight bundles parallel to the long axis of the ascus may become spirally twisted (e.g. in **Vibrissea**).

(3) Ascoconidia packed inside 4-8 "balls" become disarranged and continuously fill the whole ascus (FIG. 10).

2. Living spores within mature living asci mounted in water are narrower when compared with discharged spores due to the ascus turgor (high osmosity of the large vacuole): in some tested species of Leotiales and Rhytismatales, they were 9-15(-30)% narrower within the asci while their length was nearly unchanged.

3. Protuberant asci: asci shrink much more in length compared to paraphyses. In the living state, mature asci often greatly exceed paraphyses in length but retract below the level of the latter on killing or after spore discharge (FIGs. 8, 10, 33; De Bary, 1887: 87, 92; Buller, 1931: 247). Statements such as "asci covered by an epithecium" (composed of agglutinated apical cells of the paraphyses) often originate from dead material. Due to their turgor, living Lecanorales asci tear crevices in the epithecium (long before spore discharge takes place) by pushing the paraphyses aside (FIG. 9).

4. Septate thin-walled hyphae or spores show slight constrictions at the septa *in statu vivo* due to the internal turgor, but an even surface *in statu emortuo* (FIGs. 2 ab→ef, 13 a→b, 34 a→b). The septum is often irregularly wrinkled in the dead state (FIG. 2 ef).

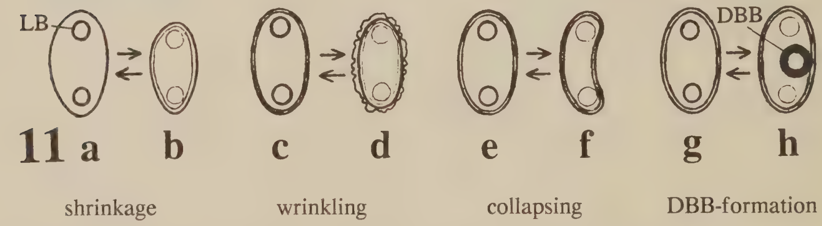


FIG. 11. Four reactions of a living cell on water loss, induced either by desiccation, or by a medium with a high osmosity.

5. False ornamentation: Ascospore walls of Pezizales are often composed of two separable layers, the outer being non-elastic, the inner elastic. As the spores die, the wall loses tension: the inner layer contracts while the outer layer becomes wrinkled by separating more or less from the inner layer. This is, e.g., the case in all studied species of **Sarcoscypha** (Baral, 1984: fig. 8). Such "false ornamentations" are not stained by CB. Zhuang (1991) described a new species, **S. striati-**

spora, differing from **S. occidentalis** merely by transverse striations on the spore wall and lower dimensions of spores and asci. Such "characters" are of no use for the delimitation against **S. occidentalis**. LE GAL (1947: 223-238) described a special type of spore ornamentation as *non calloso-pectique*, mainly in members of the Sarcoscyphinae, of longitudinal or transverse striations which are probably also a result of shrinkage of originally smooth spores. READ & BECKETT (1983) reported a reticulate surface texture characteristic of critical point-dried urediospores but a smooth surface in frozen-hydrated material. The authors consider the reticulation to be artificial resulting from shrinkage or the removal of the unfreezable (bound) water from the cell wall.

5.b. Wall thickness: the expanding wall phenomenon (imbibition effect)

Strongly thickened inner wall layers of asci (known as *apical dome/apparatus*, or *tholus*, and approximately corresponding to the endotunica = *Couche D* in REYNOLDS 1989) proved to be very useful in delimiting natural higher taxa. Such thick ascus walls differ fundamentally from solid, constantly thick walls: a thick ascus wall is indicative of the dead state while living asci show dramatically thinner walls (FIGs. 6-10), even in immature asci with a relatively low turgor (DE BARY, 1887: 87, 95; KERR, 1961: 474ff.; BARAL, 1987a: 413; 1987b: 122). Likewise, CHADEFAUD (1944: 9) figured thin and very thick apical apparati in asci of **Leotia**, and correctly referred the strong wall imbibition to the loss of turgor of the ascus vacuoles.

These wall layers represent a swellable, hydrophilous matrix with a considerable but limited expansibility: they become imbibed with water within a few seconds as soon as the asci die, either in water (naturally or by mechanical pressure, FIGs. 6, 9), or by adding lethal reagents (FIGs. 7, 8, 10; see also HOGGAN 1927: 42, pl. V, 6). Increase of about 2-5 times the original thickness usually occurs. The inner contour strongly loses contrast and may severely change its shape (FIG. 9 a→b). KOH is not necessary for the effect as was suggested by HONEGGER (1982: 213, 215) but often produces further expansion when applied to dead asci.

Amyloid layers (except for that part of the amyloid ring which protrudes into the ascoplasm) show this phenomenon also (FIG. 43 b→c). The intensity of the iodine reaction thereby logically decreases with expansion, thus a strong reaction *in statu vivo* changes to a weak or moderate reaction *in statu emortuo*.

TEM-investigations on thickened ascus walls show a loosely fibrillar organization which represents the solid part of the endotunica. The ample space between the microfibrils is clearly only present in the expanded state and should therefore be merely a watery medium; to postulate the presence of an "amorphous matrix" between the fibrils (e.g. in REYNOLDS, 1989: 13) is superfluous.

A more or less severe decrease in wall thickness of apical domes during the ascus ontogeny can be observed in dead asci (and less pronounced in living asci) (BARAL, 1987b: 124). This effect was often misinterpreted to be a result of increased turgor during maturation (e.g. by HONEGGER, 1983: 63, figs. 3a→b, 4b→c, all figured asci were killed by acrolein-glutaraldehyde/osmium-fixation). The difference in thickness is indeed also present in ruptured asci in water mounts. Thus, changes in the fibrillar compactness, which may represent different degrees of polymerisation should have occurred during maturation. Reported variation in thickness of the tholus in dead asci of **Tephromela aglaea** as depicted by HERTEL & RAMBOLD (1985) should partly be referred to this effect. My experience is that living asci show much less variability in their apical structures compared to dead asci in any group of Ascomycetes. Nevertheless, I concur with the common practice of considering the expanded apical apparatus more useful for taxonomic purposes because the amyloid structures are too compressed in the living state to be able to see the important details. The morphology of the living apical apparatus should, however, be simultaneously studied.

Since the observed decrease in wall thickness during maturation of the ascus is the result of a reduced hydration of the microfibrils, the theory of CHADEFAUD (1942: 65) and BELLEMÈRE & HAFELLNER (1982: 272) claiming resorption of wall material during the "regression" of the thickened wall layers is also superfluous.

Variation in thickness is sometimes increased in dead asci by mechanical pressure of the spores against the endotunica, especially in asci with expansible lateral walls. Thus, **Tympanis**, for example, exhibits thick apical and lateral walls in young dead, or in discharged asci but thin lateral walls in mature, non-discharged, dead asci (FIG. 10b) as a result of mechanical pressure of the numerous ascoconidia.

Many accounts of the fissitunicate ("bitunicate") ascus indicate that the wall in the upper region, especially of the immature ascus, is thickened. In the living state, however, fissitunicate asci are thin-walled at any stage of development (DE BARY, 1887: 95; HOGGAN, 1927; KERR, 1961: 475f.). The *banded pattern* or *accordion-like arrangement* of the microfibrils, considered to characterize the non-discharged fissitunicate ascus (REYNOLDS, 1971: 248, fig. 7; MÜLLER, 1981; PARGUEY-LEDUC & JANEX-FAVRE, 1982: figs. 15-20; BELLEMÈRE & HAFELLNER, 1982: fig. 6; BELLEMÈRE & al., 1986: fig. 3), occurs logically only in dead asci (FIG. 7, the fibrils are not seen with the LM). The theory of a "reorientation" of the microfibrils from a banded to a parallel pattern during elongation of the endotunica (e.g. in REYNOLDS, 1971: 254; 1989: 14) is thus superfluous.

Many attempts to reconstruct the process of spore discharge start with the false assumption that the endotunica is thick-walled prior to bursting of the ascus, or that it at least swells prior to discharge. In the Leotiales, numerous observations of spore discharge from asci in water mounts confirm that the apical dome is thin-walled as the asci explode (BARAL, 1987b: 128). The possibility of monitoring the delayed process of successive spore discharge from fissitunicate asci already led

PRINGSHEIM (1858) to the discovery that swelling of the endotunica occurs only after the last spore has been forcibly ejected.

A theory advocated by DUGHI (1957) and CHADEFAUD (1942: 59; 1973: 135f.) claims that tholi in asci of Lecanorales play a role in drought tolerance. The authors correctly refer the variation in thickness to a varying degree of hydration of the ascus wall, but thought that this variation depends upon the atmospheric humidity. The latter is not true: by mounting in oil, I found the endotunica in living asci of **Lecanora conizaeoides** to be always compressed, whether the asci were fully or partly hydrated, or dehydrated by air-drying. Furthermore, remarkable drought tolerance and longevity was found to occur also in asci devoid of wall thickenings (see also chapter 9).

Mounting fresh apothecia in concentrated ethanol, or air-dried apothecia in oil, showed dehydrated and thus thin walls in the ascus apex even in dead asci. This effect was discussed by STEINER & PEVELING (1984: 784) for ascospores with expansible septal walls. In TEM-preparations, different methods of fixation often result in different degrees of expansion (see below).

What is the biological sense of expansible inner ascus wall layers? DUGHI (1957: 13) listed 7 hypothetical functions of the tholi in Lecanorales. From the preceding, I am forced to assert that none of these hypotheses can be maintained. The process of expansion through water absorption prior to discharge must be considered an anomaly in all Ascomycetes with expansible layers: expansion occurs when asci die but never in living asci under natural conditions. Active and complete discharge from dead asci, as indicated by DUGHI, was never observed. Layers capable of expansion (= swelling in thickness) are, however, capable of enormous extension (= elongation in longitudinal direction) directly prior to spore discharge, especially in the fissitunicate ascus (DE BARY, 1887: 96; KERR, 1961: 475; BARAL, 1987b: 128). Apical rings are thereby everted prior to discharge (BARAL, 1987b: figs. 1, 7). Extensibility is presently the only function of expansible layers that I am able to accept.

That the expanding wall phenomenon in asci has almost completely been forgotten in the last decades is obvious from STEINER & PEVELING's (1984) recent account. The authors reported a similar effect for inner wall layers of the thick-walled septa in ascospores of **Caloplaca/Xanthoria** (FIG. 5), and correctly refer the swelling of the septum to the death of the spores. They do not mention, however, that thickened walls of asci show the same effect. I have found comparable expansible septa in (especially immature) spores of **Physcia**, **Rinodina**, **Massaria anomia** and **Nimbomollisia**. NANNFELDT (1983: 297) characterized the latter genus by spores having thick and "refractive" septa (*septo mediano crasso, valde refringente divisae*). Yet, only dead spores have thick septa (FIGs. 12b, 13b) while living spores show thin-walled septa (FIGs. 12a, 13a). Expansible wall layers are said to occur also in spores of Endogonaceae (SPAIN, 1990: 72, induced by acidic mountants), and in septal structures (dolipori) of Basidiomycetes (HOCH & HOWARD, 1981; LÜ & MCLAUGHLIN, 1991). The latter observed under the TEM, that the height of the pore swellings by freeze substitution was 100-184 nm (figs. 2, 4-10) but 370-475 nm by conventional chemical fixation (figs. 3, 11).

5.c. Contrast of cell walls and mucilaginous sheaths

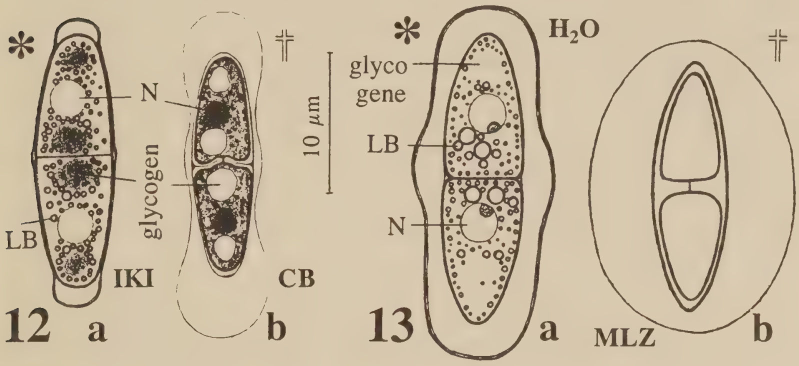
The loss of contrast of the endotunica during the death of the ascus was already mentioned above. The contrast of the spore wall inside asci becomes also often strikingly faint if asci and spores are killed by KOH, CB etc. This is due to the fact that, in the living state, the spores are surrounded by ample transparent (non-refractive) water of the vacuole(s). Therefore, the refractive spore wall markedly contrasts with the surrounding water. In the dead state, however, most of the water has escaped from the vacuole(s), and the spores are now embedded in the dead epiplasm which has a refractive index comparable to that of the spore wall. Dead ascospores inside dead asci of Leotiales can therefore often only be recognized from their LBs (in KOH) if LBs are present, while the spore wall remains quite invisible.

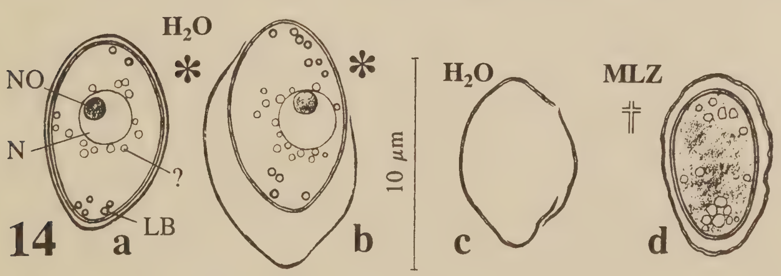
In the species of **Calycellina** with 4-spored asci in the mature stage, 8 spores are formed at first but 4 spores early abort and collapse (BARAL, 1989b). The remaining cell walls of the collapsed spores are clearly visible within living asci (FIGs. 19, 20) but entirely indiscernible in asci from herbarium material. Therefore, this interesting situation has not been reported by other authors.

Coalesced LBs may simulate septa (FIG. 22). In living multiguttulate spores true septa are not easily seen but recognizable by slight constrictions of the spores at the septa and by the nucleus in the middle of each cell (FIGs. 1a, 2ab). True septa often become more obvious when mounting in MLZ, CB etc. (FIG. 7b), but then the asci are killed and, therefore, the degree of maturity of the spores, i.e. the number of septa in the mature spore, is not further recognizable (see chapter 8). BOUDIER (1886: 143f.) recommended to stain *in statu vivo* by IKI in order to see septa more clearly.

The presence or absence of croziers on the ascogenous hyphae, recently re-introduced by HUHTINEN (1990a: 66) as a very important taxonomic character in **Hyaloscypha** and allied genera, is rapidly seen *in situ* in sections through living young apothecia in most taxa of Leotiales (avoid pressure on the cover slip). In dead hymenia, however, the feature is often indiscernible when water, MLZ or CB is used. Mounting in Congo red (gently heated) as HUHTINEN recommended (in litt.), or in KOH as I prefer in the case of herbarium material, usually allows this feature to be seen when separating the tissue by pressure, but it is very often highly time-consuming to be certain about it. The feature has a high significance for the delimitation among the species of Leotiales: 77% of 767 species so far studied by me have croziers but 22% have not. About 1% seem to be variable.

Mucilaginous appendages or sheaths of spores are often overlooked in herbarium material. Sheaths swell considerably after spore discharge (INGOLD, 1978; BRUMMELEN, 1967: 39), or if asci are killed together with their spores, rarely even within the living ascus, and thereby lose refractivity and contrast (FIGs. 12 a→b, 13 a→b). Obviously, a delicate semipermeable membrane covers the exterior of the mucilage. These sheaths have wrongly been thought to supply the internal pressure for spore discharge by several workers. Numerous observations on living material proves, however, that the sheaths are always dehydrated and appressed to the spore wall shortly before and during spore discharge. In dead non-discharged asci they are strongly swollen and fill the space between spore and ascus wall. In some taxa these sheaths stain violet in CRB.





FIGs. 12-13. Spores of **Nimbomollisia** observed in the living versus dead state. The expansion of the mucilaginous sheath occurs when spores are killed but also in the living state: sheaths are compressed inside living asci and expand sooner or later when spores are discharged or when asci die prior to discharge. Note shrinkage of spores and thickened septum. **FIG. 12. N. eriophori**, **FIG. 13. N. melatephroides**. 2000x.

FIG. 14. Non-mucilaginous sheath (perispore?) in spores of **Ciboria caucus**. The sheath bursts and finally separates due to imbibition of the living spore after discharge (a→b→c). **a.** spore inside living ascus; **b.** spore immediately after discharge; **c.** completely separated sheath; **d.** anomalous separation from the spore wall without bursting due to shrinkage of the spore after killing by MLZ. 3000x.

Other taxa have very thin sheaths of mucilage on the ascospores which become only visible in the case they are stained by CRB showing a weak or deep reddish-violet. This feature of high taxonomic value occurs, e.g., in the species of **Pezicula**, in several species of **Calycellina** (BARAL, 1989b: 212) and **Ombrophila**, in **Calycina alniella**, **Hyaloscypha aureliella**, and **Durella connivens**. **H. aureliella** is easily distinguished from **H. britannica** var. **britannica** by this reaction. The reaction seems so far unreported for the Leotiales. GRUBE & HAFELLNER (1990: 307) found a red-violet stain of the spore wall in some species of **Zwackhiomyces** using aqueous methylene blue. I found this dye to give only a weak bluing to spores reacting deep violet in CRB. CB gave always negative results due to the presence of lactophenol as did CRB + lactophenol. This type of reaction should therefore be distinguished from blue (*cyanophilous*) reactions in CB and is better termed *metachromatic* (see SINGER, 1986: 80, *metachromatism with cresyl blue*).

A delicate, scarcely mucilaginous but inelastic, unstainable sheath (perispore?) was found to occur very frequently in spores of Leotiales. This sheath bursts by separating from the true spore wall after discharge, due to release of ascus turgor and therefore increase in the spore volume (FIGs. 14, 22a, 35a). The spore thereby completely slips out of its sheath. Such sheaths appear not to have been reported in this order by other authors, probably because they are very difficult to see in herbarium material.

6. ALTERATIONS IN THE CELL CONTENTS

Fungal cells often contain more or less refractive cytoplasmic inclusions. BOUDIER (1886: 143; 1907: 28; 1914: 51) was one of the few taxonomists who have emphasized the fact that, in the living state, these inclusions show a strikingly stable and regular image which often serves as an *excellent criterion* in the taxonomy of Ascomycetes. My observations on numerous species confirm BOUDIER's statements. The delimitation among many taxa becomes decidedly facilitated if guttules inside living spores and paraphyses are used as additional features. Dead cytoplasm, however, shows highly variable patterns; its morphology depends furthermore on the mounting medium, and many types of inclusions can no longer be discerned. The variable morphology of the cell contents in different states and development stages observed in water mounts misled many researchers (e.g. KILIAS, 1981: 269) to disregard cytomorphological features and to prefer mounting media which clear the contents and kill the cells. Workers accustomed to studying dead spores sometimes believe the interior of the living spores to represent an anomaly: BENKERT (1976: 632), for example, assumed that the multiguttulate (living) spore in **Melastiza chateri** (FIG. 16f) is an anomalous state while the biguttulate (dead) spore (FIG. 16g) represents the normal case.

Refractive cell inclusions are best visible in the fully hydrated cytoplasm (in water mounts) using bright field optics. The contrast of the inclusions depends on various circumstances: it decreases with increase of the magnification used, and with higher refractive index of the cytoplasm, e.g. by natural dehydration of the spores during maturation in many Pezizales. Applying phase-contrast proved only superior with large cells, but seems useful when mounting in a plasma albumin medium which has a high refraction but a low osmosity (BARER et al., 1953).

6.a. Lipid bodies (LBs, "oil drops")

Lipid forms globose refractive bodies of about 0.2-10 μm diam. within the cytoplasm outside the vacuoles. In germinating spores the lipid usually disappears and serves as an energy and carbon reserve (STEINER, 1957: 242; SUSSMAN & DOUTHIT, 1973: 315; WEETE, 1981: 465). For a review of LBs in plant cells see GURR (1980) and WANNER et al. (1981), for fungi see HESS (1981) and WEETE (1981).

Recognition:

Recognition of lipid can be made by two tests (BARAL, 1989a): (1) 1-5% KOH does not dissolve LBs when added to living or dead cells (LBs remain visible in full strength, even after boiling); (2) staining with CRB is negative while CRB_A stains LBs within dead cells yellowish-amber to deep copper-orange.

Lipophile dyes are commonly used to give more or less specific stains for fatty matters (see KIRK, 1966: 87ff.). Most of these tests are lethal to the cells. I have tested Sudan III in lactic acid in several species: a distinct reddish stain of the LBs was rapidly obtained especially after heating the slide while CRB_A gave the characteristic amber stain. KIRK (l.c.) recommended two tests (using benzapyrene-caffeine, and neutral red) for staining LBs *in statu vivo* by fluorescence.

KORF & ERB (1972) and KORF (1977) found **Trichophaeopsis bicuspis** to differ from **Trichophaea** by ascospores with "non-oleaginous, somewhat resinous inclusions" instead of LBs since the inclusions failed to absorb oil stains such as Sudan IV. My material of **T. bicuspis** showed two polar LBs 3.5-4 μm in size. Indeed, the whole spore content remained unstained by CRB_A or Sudan III for hours, even after boiling, except for immature, and ruptured mature spores, where the LBs stained amber in CRB_A and red in Sudan III. Thus, negative result is clearly due to the impermeability of the thick wall of the mature spore to these dyes.

Formation:

LBs in ascospores either originate from minute precursors (FIGs. 15b, 16b; BARAL, 1984: fig. 7) or are already present in the cytoplasm of the ascus before the spores are formed (FIG. 42a). LBs increase during sporogenesis (without fusing) to a very different size, depending on the species (FIGs. 15, 16, 42).

Distortion:

Coalescence (fusion) of several LBs is frequently found in dead spores in a fresh ascocarp (and also in other groups of fungi with spores with high lipid contents), and is considered an anomaly caused by damage to the limiting membrane of the single LBs (HEINEMANN, 1956: 40ff.; STEINER, 1957: fig. 18; CUNNELL, 1959: 465; FREY-WYSSLING & MÜHLETHALER, 1965: 168ff.; KIRK, 1966: 70; GURR, 1980; WANNER & al., 1981). LBs may thereby lose their spherical shape by forming irregular aggregations with the surrounding cytoplasm (FIGs. 1 a→d, 2 ab→cef, 7 a→b, 16 f→g, 21 a→b, 22 a→b; HUHTINEN, 1990a: fig. 175c, H_2O→MLZ). STEINER pointed out that such state-dependent effects were the reason why cells of **Saccharomyces cerevisiae** have erroneously been thought to vary considerably in oil content (indistinctly multiguttulate *in statu vivo*, one large distinct drop *in statu emortuo*). According to KIRK (l.c.), *no fixatives entirely prevented guttular oil from spreading throughout the spores.*

On the other hand, coalescence does (? regularly) not occur if spores have died in the dried state whilst lying in the herbarium: spores inside asci exhibited undamaged guttule patterns even in about 100 years old dried material when studied in KOH.

Coalescence of the LBs can be induced within a few seconds when killing multiguttulate spores by adding ethanol, HCl (STEINER, l.c.), CB or MLZ to the water mount, or can be observed in spores in water as they die. Thereby, coalescence occurs some seconds or minutes prior to the loss of cell turgor (see FIG. 2c where the small LBs have coalesced in the living spore). The contrary process, the formation of many small drops from one large drop, though reported by researchers, was never observed, either by me or by CUNNELL (l.c.). Note, however, that multiguttulate immature spores may regularly develop into oligoguttulate mature spores, for example in the genus **Octospora**. This effect occurs without fusion of LBs: only one or few of the small LBs grow to a large size so that the remaining small ones are overlooked when viewed at a low magnification. Such a case is figured by JOHNSON (1963: pl. 33, figs. 1-6) for living asci of **Ceriosporopsis**.

A few seconds after coalescence takes place, the lipid often disappears optically (in MLZ, CB, or water): due to (1) the loss of cell turgor and therefore dehydration of the cytoplasm (increase in refraction, FIGs. 15g, 16g), (2) the fact that in shrunken spores with a high relative lipid content the lipid continuously fills the whole cell (FIGs. 2d, 5b), or (3) a high refractive index of the employed mountant which imbibes the cytoplasm around the LBs (FIGs. 8b, 12b, 13b). These effects explain why LBs in spores with rich lipid contents are frequently figured "empty" in many publications (without comment), provided that the contents were not omitted intentionally. HERTEL (1967: 15), KORF (1977), SPOONER & DENNIS (1985: 298) and SVRČEK (e.g. 1989: 72) reported guttules (certainly LBs) "disappearing" from spores after prolonged preservation in the herbarium, or when mounted in MLZ or CB. RAMSBOTTOM (1916) already drew attention to the "disappearance" of guttules in spores when mounted in glycerol: *In no case have guttulae been* *observed in the collection of Discomycete slides preserved in the National Herbarium.* The lipid reappears, however, with more or less strong contrast even in old herbarium specimens if the spores are mounted in 1-5% KOH (KORF, l.c., obtained this effect using KOH-phloxine-glycerol). A varying refractivity of the cytoplasm is also the reason why DODGE (1957) reported the LBs to "disappear" reversibly during DBB-formation (FIG. 11 g→h).

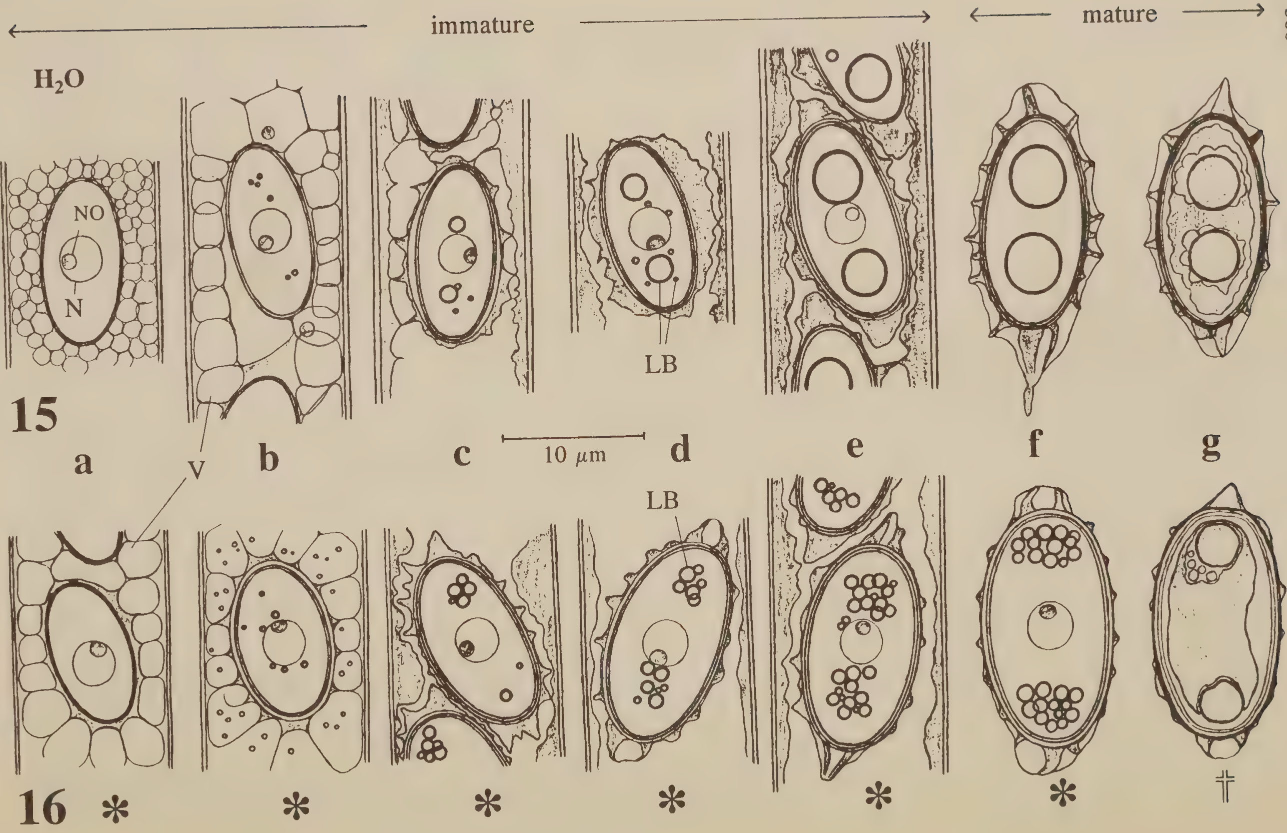
When living spores pass into the germination phase, the lipid is actually broken down and used for energy production and synthesis of new cellular material (DE BARY, 1887: 113; GARRAWAY & EVANS, 1984: 227). It is therefore very important for the purpose of taxonomy to use only mature spores for the study of spore guttulation (see chapter 8).

Taxonomic value:

BOUDIER (1907: 28; 1914) drew attention to the taxonomic importance of LBs in ascospores and regretted the fact that workers have often ignored the guttules in their descriptions. LE GAL (1947) gave a survey of the various types of guttular patterns in the spores of Pezizales. HERTEL (1967: 15) emphasized the taxonomic use of guttules in spores of Lecanorales. KARSTEN (1871) already noted spore guttulation in many species. Many other authors included this feature in their descriptions but few took influences of their methods into account. *The importance of fresh material for species diagnoses, especially for noting ascospore guttulation, cannot be overstated* (HARRINGTON, 1990: 436). Since lipid serves as a nutritive substance, differences among related taxa in the amount of lipid within mature spores seem to reflect differences in ecological adaption in regard to spore germination.

In mature ascospores the total amount of lipid often severely varies between closely related species (**Calycellina**, FIGs. 19-20, **Lasiobelonium**, FIGs. 17-18). Similarly, **Morchella**, **Cheilymenia**, **Tricharina** and **Peziza** p.p. ("**Aleuria**") differ from **Helvella**, **Scutellinia**, **Trichophaea** and **Peziza** p.p. ("**Galactinia**") (BOUDIER, 1885: 101, 104, 105; 1914: 54; KORF, 1977; BARAL, ined.), or **Ciboria** from **Rutstroemia** (BARAL & KRIEGLSTEINER, 1985: 10, 19) in the absence versus abundant presence of LBs in the spores. HUHTINEN (1990a) considered **Calycellina lutea** a possible synonym of **C. lachnobrachya** (as "**Phialina**"). The spores of **C. lutea** are misleadingly depicted eguttulate in the original description. Yet, these contain many LBs in contrast to **C. lachnobrachya** with a low lipid content (FIGs. 19-20). Likewise, **Lasiobelonium variegatum** and **L. corticale** have often been confused because, besides other features, the striking difference in the lipid content was overlooked (FIGs. 17-18). Numerous other such "critical" species can be separated on the basis of the quantities of lipid.

CHADEFAUD (1969: 195) characterized different orders of pyrenomycetes by the lipid content in ascospores (*type «pauvre»* versus *type «riche»*). WEETE (1981: 464) stated that the *lipid content of spores of most fungi generally ranges between*



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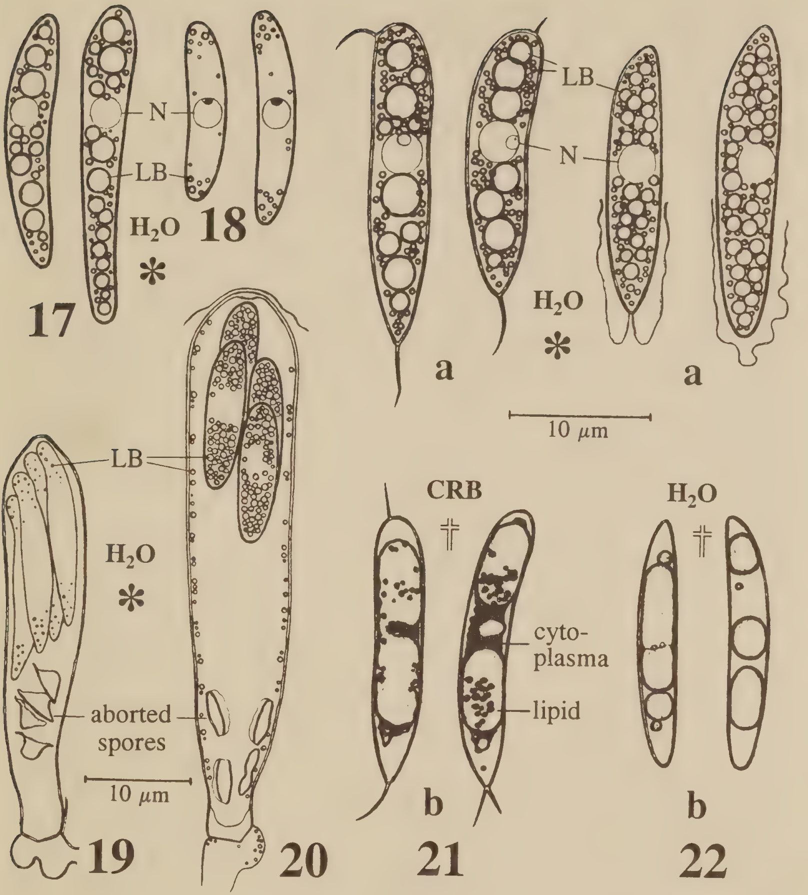
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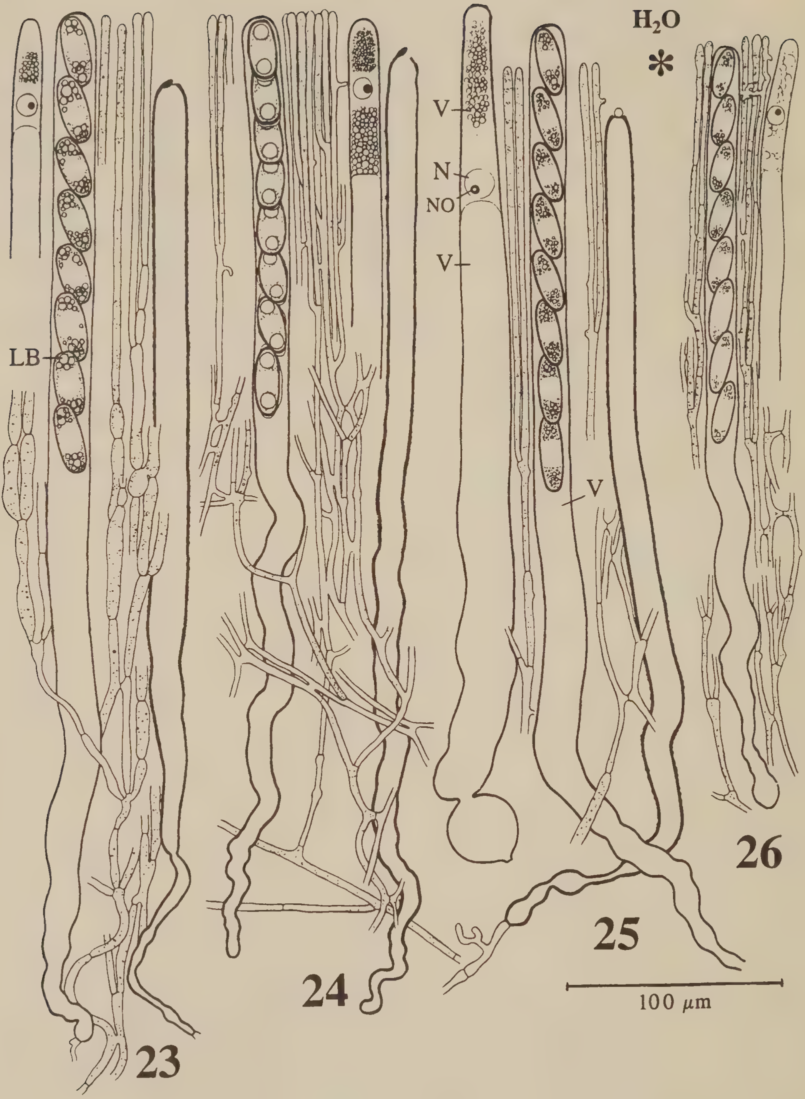
FIGs. 15-22. Four taxon pairs, easily distinguished in the living state by the lipid content of the mature spores (high versus low content: FIGs. 17-20; few large versus many small LBs: FIGs. 15-16, 21-22). Note that (1) coalescence of LBs obscures the distinctive features (FIGs. 15/16 f→g; 21/22 a→b), (2) LBs are absent in the first stage of ascosporogenesis in certain taxa (FIGs. 15a, 16a), but present in others (FIG. 42 abc). **FIG. 15. Aleuria aurantia, FIG. 16. Melastiza chateri** (1500x); **FIG. 17. Lasiobelonium corticale, FIG. 18. L. variegatum** (2000x); **FIG. 19. Calycellina lachnobrachya, FIG. 20. C. lutea** (1500x); **FIG. 21. Hymenoscyphus scutula, FIG. 22. H. consobrinus** (2000x, the dead spores were found in the squash mount together with the living spores). (FIGs. 19-20 from Baral 1989b).



FIGs. 23-26. The four European species of **Sarcoscypha** distinguished, besides other features, by the size of the lipid bodies in the ascospores (from BARAL, 1984: fig. 4, this figure was unintentionally issued only with its upper half, and is here reproduced in its full extent). **FIG. 23. S. austriaca** (neotype), **FIG. 24. S. jurana, FIG. 25. S. coccinea** (neotype), **FIG. 26. S. macaronesica** (holotype). (300x).

5 and 17% of their dry weight, but spores of some species such as rusts may contain up to 35%. I have estimated the total volume of lipid in relation to the volume of the living hydrated spore by the area fraction of the LBs in optical section which is proportional to their volume fraction (WEIBEL et al., 1966). I use the following linear scale: 0 = devoid of lipid; 5 = maximum lipid content. In the ascospores of 815 tested species of Leotiales, these categories were represented in quite equal frequencies, with a slight maximum towards the lower contents: 0-1: 21%; 1-2: 25%; 2-3: 18%; 3-4: 16%; 4-5: 20%. Usually, there is little variation within a species if only living mature ascospores are taken into account.

Differences in the lipid content of asci prior to spore formation are outstanding between certain taxa although, in these case, the spores are finally always rich in lipid: asci of **Pezicula** (FIG. 42) and **Pachyella babingtonii**, for example, have high contents in the stage around meiosis while those of **Sarcoscypha** (FIGs 23-26), **Otidea** and many studied Humariaceae (FIGs. 15a, 16a) have very low contents.

The size of the single LBs in spores (few large versus many small LBs) is a further, usually consistent feature which supports delimitation among many species (FIGs. 15f-16f, 21a-22a). In **Sarcoscypha** (FIGs. 23-26), the size of the larger LBs allows the delimitation among species (BARAL, 1984). Living spores have been studied from 26 collections of **S. jurana**, 30 of **S. austriaca**, 14 of **S. coccinea**, and 4 of **S. macaronesica**. The features were consistent: The first species showed the largest LBs and occurred only on **Tilia**, the second had medium-sized LBs and produced conidia on the ascospores, the two latter differed by small LBs and obtuse spores.

According to DENNIS (1978: 400), Dothioraceae and Dothideaceae usually differ in multiguttulate versus uni- or biguttulate cells of ascospores. HEINEMANN (1956: 41ff.) found **Saccharomyces cerevisiae** to differ *in statu vivo* by cells with many LBs from other Endomycetales having cells with one large and a few small LBs. The Helvellaceae (**Discina**, **Helvella**, **Rhizina**) are characterized by spores with usually one large central LB with some accessory LBs while **Gyromitra** (Morchellaceaea) is strictly biguttulate (BENEDIX, 1966: 360, figs. 1, 2, 4, 5; BARAL, ined.). HERTEL (1967: 15, pl. 15) used different amounts and patterns of lipid in living ascospores of **Lecidea** as a character on the specific level. In the genera **Lecanora** and **Diaporthe** I observed species with multiguttulate spores (FIG. 9) and other species differing by strictly biguttulate spores.

6.b. Refractive vacuolar bodies (VBs)

Normal living fungal vacuoles are totally non-refractive and can be detected under the LM as transparent ("empty") regions within the cytoplasm (FIGs. 27, 28, 31, *V*). CRB or $\mathrm{CRB_A}$ gives a homogeneous violet stain to the vacuoles (typical for the single large vacuole in mature asci), or mostly induces flocculation of blue-violet MCs in the vacuole sap (FIGs. 4, 30). A phenomenon characteristic of a major part of the Leotiales (but absent in the other part) is, however, the presence of a specialized type of vacuole side by side with the normal type (FIGs. 27-29, 32-33, *VB*; HUHTINEN, 1990a: fig. 255c, H_2O). This special type contains a colloidal substance of a more or less high refraction within the tonoplast, with the vacuoles appearing "full". Here, CRB never induces the formation of MCs but rather stains the bodies in a homogeneous turquoise-blue. GUILLERMOND (1941: 161, 181ff.) and BANCHER & HÖFLER (1959: 152) described similar vacuoles occurring in vascular plants as opposed to normal vacuoles: highly refractive, more acid, staining *in statu vivo* blue or green by CRB, reducing osmic acid, rich in phenolic compounds (tannin).

Such *refractive vacuolar bodies* (*VBs*), as I term this type of inclusion, occur predominantly towards the surface of the ascocarp: in the top cells of paraphyses, outer excipular cells, or basal part of hairs (FIG. 32). BELLEMÈRE (1958) described them in **Cyathicula coronata** as *granulations réfringentes, brunâtres après coloration par la réaction de A. Prenant* in paraphyses and cortical hyphae. Due to their refraction they have mostly been misinterpreted as lipid bodies (see BARAL, 1989a: 120; 1989b: 225). In certain genera, IKI or MLZ give a reddish-brown reaction to VBs (see BARAL, 1987a: 424; SVRČEK, 1989: 73; HUHTINEN, 1990: 71, as *golden*). The IKI reaction is stable while the MLZ reaction disappears within about 1/2 min. In many mollisiaceous fungi, KOH provokes a deep sulphur-yellow reaction with the VBs (see chapter 7). Hydrophilous (mainly yellow) pigments sometimes occur in VBs (FIG. 32). On the other hand, oxidative color changes to yellow or reddish-brown often occur when cells are injured (this supports the idea that phenolic compounds are involved). Therefore, what HUHTINEN (1990a: 71) described as *yellow pigment* mainly from herbarium specimens and found to be diagnostic for **Calycellina** (as "**Phialina**") is just the same as what I term *VB*. I have found VBs also in vegetative surface cells of Basidiomycetes (**Clavariadelphus**, **Ramaria**). The greenish-blue (turquoise) color of VBs, obtained by staining *in statu vivo* with CRB or toluidine blue, is a purely metachromatic effect and does not indicate a more acid pH because, in the case of toluidine blue, changes in the pH do not affect the color of the dye. According to HARMS (1965, II: 19), basic dyes do not permit a clear evaluation of the pH inside the vacuole.

Recognition:

Delimitation from LBs can be made by two tests: (1) VBs are dissolved instantaneously (complete optical disappearance) by 1-5% KOH (but not by even strong acids) when added to living cells (FIG. 33 a→b, c→d); (2) staining *in statu vivo* with CRB or CRB_A always gives a strong pure turquoise-blue (metachromatic) color to hyaline VBs (BARAL 1989a: 121) within a few minutes.

Numerous taxa have been tested, but only a single exception was found: in species of **Symphyosirinia**, the large conidia of the anamorph are completely filled with strongly refractive VBs which stain deep turquoise in CRB but are not dissolved when killed by a strong KOH-treatment.

Formation:

The refractive substance becomes apparent inside young small vacuoles, e.g. at the tip of paraphyses, as a colloidal solution. During development VBs increase in size. Two main types can be distinguished: (1) multiguttulate type (FIGs. 27, 33): many small vacuoles are formed at the beginning; these later grow in size while the substance sooner or later precipitates within the single vacuole by forming many small globose VBs which show Brownian movement in the transparent vacuole sap (lower part of paraphyses); (2) elongate type (FIGs. 28, 29, 32): few large vacuoles are formed in which the substance remains colloidal in the living state. Intermediate types also occur representing type (1) but with VBs remaining permanently colloidal in the living state.

Due to the mentioned ontogenetic changes in size and shape of the VBs, there is often a slight variation from young to mature apothecia. The feature is, however, highly stable in most taxa if only adult living cells are considered.

Distortion:

Lethal mountants (MLZ, CB, KOH) destroy VBs resulting in their complete invisibility (FIG. 33; see HUHTINEN, 1990a: fig. 255, H_2O vs. MLZ). KOH probably provokes hydrolysis of the refractive molecules. VBs may also disappear within less than 1 sec. if the cells die during examination of a water mount, possibly due to a raised pH when the tonoplast bursts. Herbarium material often lacks any remnants of VBs or shows irregular bodies with often altered pigmentation which are then KOH-insoluble (FIG. 1f; HUHTINEN, 1990a: figs. 212-261, illustrated as black intracellular spots).

Taxonomic value:

VBs in paraphyses and in cortical cells or hairs are of importance in the following examples: **Cyathicula** is easily distinguished by strongly refractive VBs of the multiguttulate type (FIG. 27) and blue reacting apical rings of the **Hymenoscyphus**- or **Bulgaria**-type from **Allophylaria**, which has elongate VBs (FIG. 28) and red reacting apical rings of the **Laetinaevia**-type (BARAL & KRIEGLSTEINER, 1985: 108; BARAL 1987b). Variation in the type of VBs was only seen in 2 of the 13 studied species of **Allophylaria** (showing a tendency to multiguttulation), and in 1 of the 20 studied species of **Cyathicula** (showing a weak refraction). Due to lack of fresh collections there is still no information available about the paraphysis content in the type species of **Crocicreas** which would help in clarifying its relation to **Cyathicula** which was placed in synonymy of **Crocicreas** by CARPENTER (1981). Whilst monographing this large genus, CARPENTER almost completely ignored VBs (but several reports of yellowish contents and a darker stain of the paraphysis plasma by CB or MLZ give indirect indication of their presence). He therefore classified a typical **Allophylaria**, **A. subhyalina**, in **Crocicreas**.

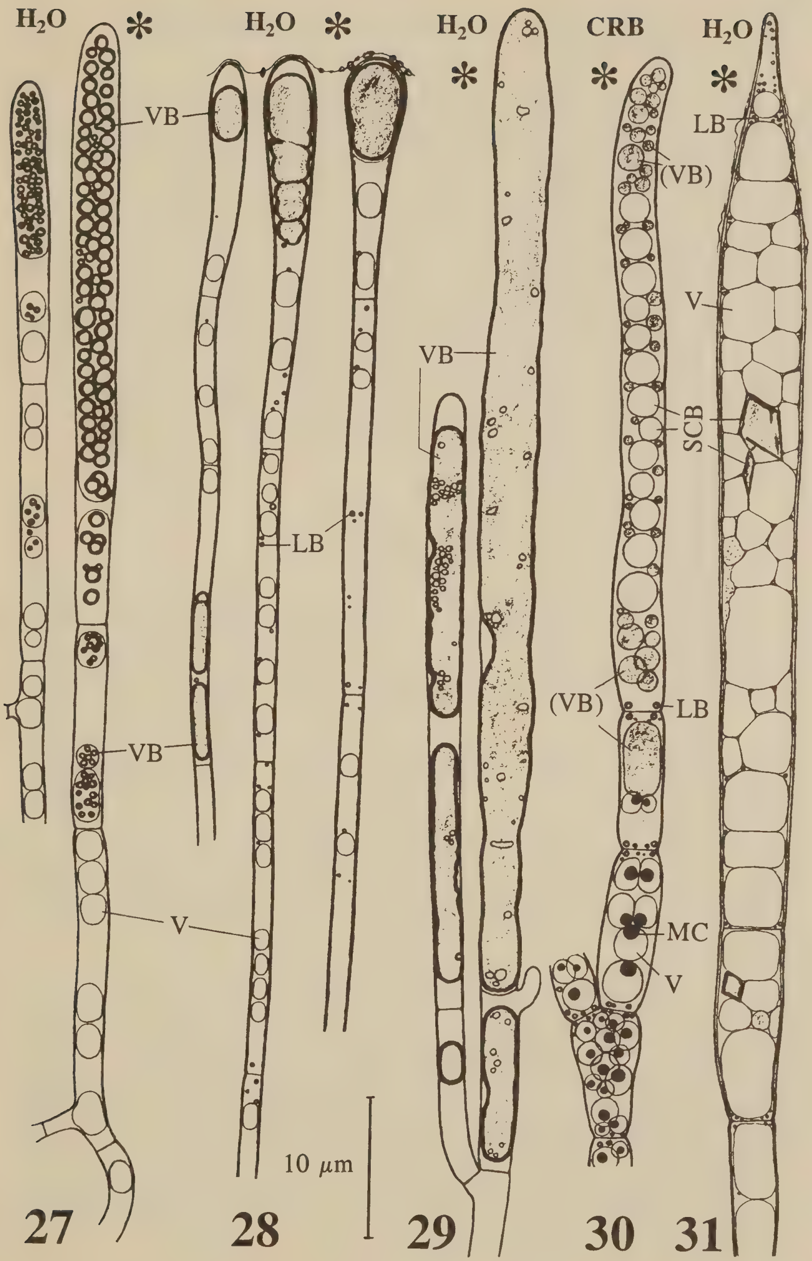
A similar case probably requires a generic split within the genus **Bisporella**: **B. pallescens** and **B. subpallida** have multiguttulate VBs and apical rings of the **Hymenoscyphus**-type, while **"B." citrina**, **"B." lactea**, **"B." sulfurina** and **"B." scolochloae** have elongate VBs (the two former species have apical rings of the **Laetinaevia**-type, the two latter are IKI-).

Mollisia/Tapesia (FIG. 29) and **Calycellina/Phialina** (FIG. 32) are characterized by highly refractive, more or less elongate VBs while **Pyrenopeziza/ Pirottaea** (FIG. 30) and **Hyaloscypha** show globose VBs of very low or vacuoles lacking refraction (BOUDIER, 1885: 119; BARAL & KRIEGLSTEINER, 1985: 35; BARAL, 1989b; HUHTINEN, 1990a: 71). The observed variation was as follows: in **Mollisia** s.l., 44 studied species showed medium to strong refraction while 10 showed low or lacked refraction; in **Pyrenopeziza** s.l., all 27 species showed low or lacking refraction. All 30 studied species of **Calycellina** s.l. had medium to strong refraction but 12 out of 13 studied species of **Hyaloscypha** showed no refraction while only 1 (**H. secalina** var. **paludicola**) differed in having strongly refractive VBs. Refractive VBs of the multiguttulate type are typical in the "**Hysteropezizella**-complex".

In **Lachnum** s.str., 18 out of 46 studied species showed multiguttulate VBs (FIG. 33) whilst 26 lacked VBs (2 are variable), and it is the VBs which are responsible for the reddish color change of the white apothecia (BARAL & KRIEGLSTEINER, 1985: 73). The apices of **Botryotinia** paraphyses (5 studied species) contain ochraceous refractive VBs which are absent in **Sclerotinia** (3 species) and **Myriosclerotinia** (2 species). This seems an unpublished feature which supports the justification of the genus **Botryotinia**, recently put back in synonymy of **Sclerotinia** by SPOONER (1987: 202ff.), who regarded the difference in conidial states as no more than of subgeneric value. **Discina ancilis** and **D. gigas** show ochraceous, strongly refractive VBs of the multiguttulate type (FIG. 40a) which **Gyromitra esculenta** lacks.

Distinct VBs rarely occur in spores. They are characteristic, however, of ascospores of certain taxa, a hitherto overlooked phenomenon, e.g., of most species of **Orbilia** (FIG. 37, showing a highly characteristic shape), of **Hymenoscyphus** cf. **sazavae** (FIG. 35a), and of **Tubeufia paludosa** (FIG. 34c). Vacuoles of low refraction often occur in ascospores of Leotiales (FIG. 36; CHADEFAUD, 1969: 191, figs. 8a, 9b, 10b).

FIGs. 27-31. Five species differing by the contents in their paraphyses (refractive versus non-refractive, multiguttulate versus elongate, restricted to the tip of paraphysis versus reaching down towards the base). Note difference in refraction between non-refractive vacuoles (*V*) and strongly refractive vacuolar bodies (*VB*) (in FIG. 30 the VBs have a very low refraction). The metachromatic corpuscles in FIG. 30 are produced through staining *in statu vivo* with CRB, all other structures are present without any treatment. **FIG. 27. "Conchatium" fraxinophilum** (= **Cyathicula fraxinicola**), **FIG. 28. Allophylaria nervicola**, **FIG. 29. Mollisia** spec., **FIG. 30. Pyrenopeziza petiolaris**, **FIG. 31. Brunnipila clandestina**. 2000x.


H$_2$O
*
VB
VB
V
H$_2$O
*
VB
LB
V
10 μm
H$_2$O
*
VB
CRB
*
(VB)
SCB
(VB)
LB
MC
V
H$_2$O
*
LB
V
SCB
27
28
29
30
31

6.c. KOH-soluble cytoplasmic bodies (SCBs)

Vegetative cells of Leotiales may contain globose (FIG. 30) or crystalline (FIG. 31) bodies (here termed *SCBs = soluble cytoplasmic bodies*) of low to high refraction which dissolve in KOH but do not stain with CRB in the living state while adjacent vacuoles are deeply stained. SCBs are localized in the cytoplasm outside the vacuoles. With this set of characters, SCBs resemble WBs but differ in being not associated with septal pores. The contrast of the bodies increases upon staining *in statu vivo* with IKI. Their nature remains unclear; literature reports for Ascomycetes have not been found. GUILLERMOND (1941: 206, fig. 144) described similar crystalloid proteinaceous bodies in cells of lower fungi. Globose SCBs are characteristic of paraphyses of **Pyrenopeziza** (FIG. 30) including "**Pirottaea**", crystalline SCBs occur in paraphyses of **Brunnipila** (FIG. 31) and **Trichopeziza**. **Hyaloscypha albohyalina** var. **albohyalina** (or **H. vitreola**?) is distinguished by the presence of refractive globose to elongate SCBs in paraphyses and excipular cells from **H. albohyalina** var. **spiralis** where these bodies are absent.

6.d. Woronin bodies (WBs)

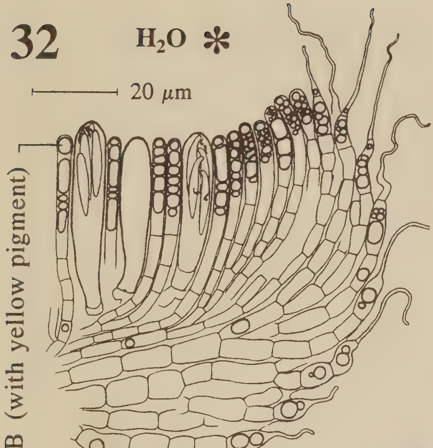
Most families of Pezizales are characterized by refractive WBs in the cytoplasm a short distance from the septal pores within the vegetative cells, about 3 to 12 per septum, e.g. two on each side (FIGs. 38-41). Their size is about 0.3-0.8(2.5) μm, their shape either globose or crystalline, and their composition proteinaceous

FIG. 32. Section through the margin of **Calycellina ulmariae** (from BARAL, 1989b). Note that the deep yellow VBs occur preferably at the surface of the apothecium. 600x.

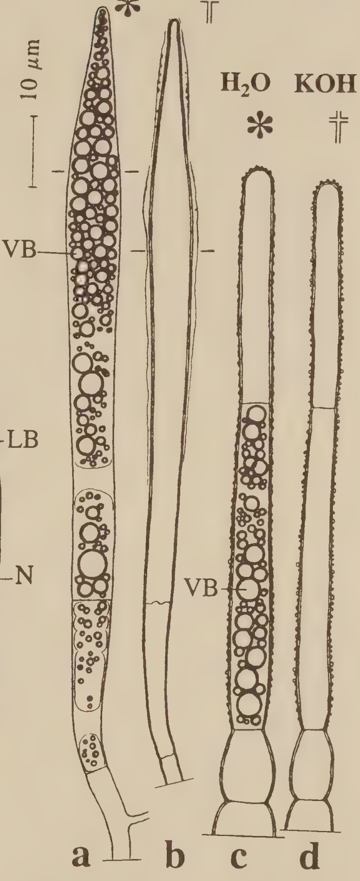
FIG. 33. Paraphysis and hair of **Lachnum controversum**, **a.**, **c.** living state, **b.**, **d.** the same cells a few seconds after killing by KOH. KOH dissolves the VBs instantaneously. Note shrinkage of cells especially in width. The horizontal lines on both sides of the widest part of the paraphysis mark the level of the apex of the mature asci. 1500x.

FIGs. 34-37. VBs in ascospores. Note that LBs and VBs in these examples (except FIG. 36) have the same refraction and color, and partly even the same shape. Yet, CRB stains VBs blue but LBs not (FIG. 34c), and KOH dissolves the VBs instantaneously while the LBs persist (FIG. 34b, 35b). Note shrinkage of spores in KOH. **FIG. 34. Tubeufia paludosa**, **FIG. 35. Hymenoscyphus** cf. **sazavae** (= **Helotium sulphuratum** ss. BARAL & KRIEGLSTEINER 1985: 137), **FIG. 36 a. Cistella deflexa**, **b. Phaeohelotium geogenum**, **FIG. 37 a. Orbilia sarraziniana**, **b. Orbilia** spec., **c. O. septispora**, **d. O.** cf. **rosella**, **e. O. auricolor** (= **O. curvatispora**), **f. O. delicatula** (= **O. xanthostigma** s.auct.). 2000x. (FIG. 37c from BARAL, 1989a). FIGs. 34 and 35 show the same spore in water (a), and after KOH has been added (b).

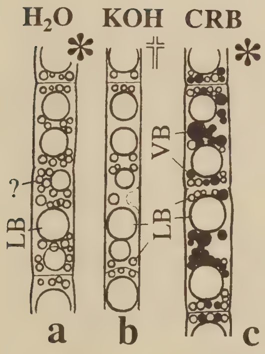
32

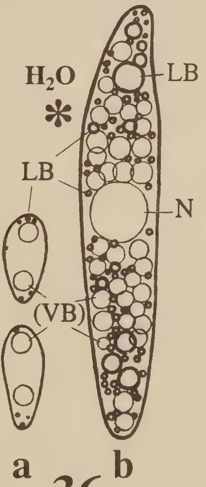

H$_2$O *
20 μm
VB (with yellow pigment)

33

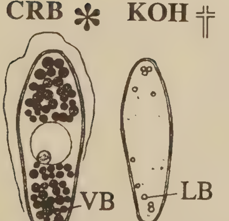

H$_2$O
KOH
*
†
10 μm
VB
H$_2$O
KOH
*
†
VB
a
b
c
d

34

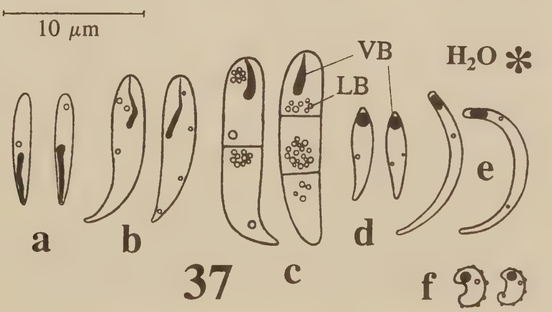

H$_2$O
KOH
CRB
*
†
*
?
LB
VB
LB
a
b
c


H$_2$O
*
LB
LB
N
(VB)
a
b

36


CRB *
KOH †
VB
LB
a
b

35


10 μm
VB
LB
H$_2$O *
a
b
c
d
e
f

37

(KIMBROUGH, 1991: 425). I have also seen WBs in species of the Sclerotiniaceae. WBs were thought to function as a pore plugging mechanism, sealing off living from dead cells (KIMBROUGH & CURRY, 1986) but KIMBROUGH (1991: 425) now considers non-proteinaceous structures to be more important in septal plugging. Like SCBs, WBs dissolve in 1-5% KOH (but not in nitric acid) and are not stained with CRB. They have often been observed with the LM (e.g. by CORNER, 1929: 271), but can only be seen in living cells.

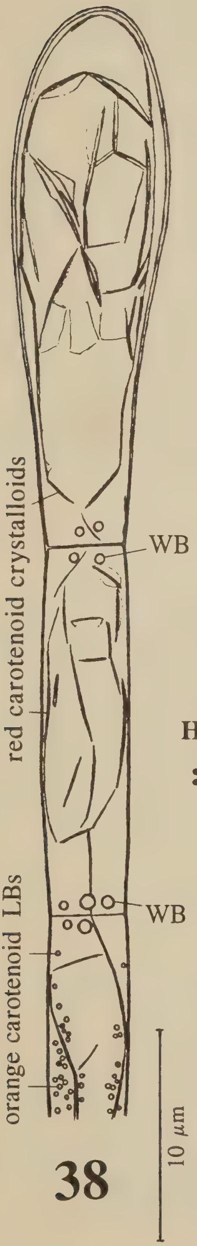
WBs have been used in the systematics of Ascomycetes (e.g. by KIMBROUGH & CURRY, 1986). A special type of WB characterizes **Morchella**, **Verpa**, **Disciotis**, **Gyromitra** (Morchellaceae), and **Discina** (Helvellaceae) (FIGs. 40, 41) but is absent in **Helvella**: several very thin flat crystals of a regular hexagonal outline measuring about 1-2.5/0.2-0.3 μm lie close to the pore. KIMBROUGH (1990; 1991: 422) misleadingly described the WBs of this type as "extremely elongate, rectangular" because, in TEM-sections oriented vertically to the septum, they appear in cross-section as rod-shaped structures. Thicker crystalline hexagonal WBs, however, have been found with the TEM in several non-morchellaceous genera (FIG. 39b; KIMBROUGH 1991: 425).

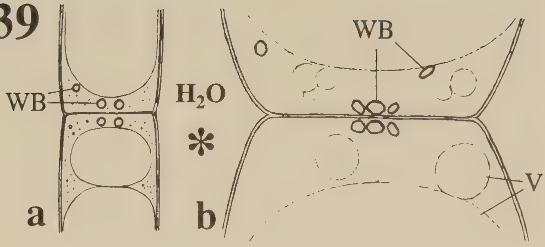
6.e. Pigments

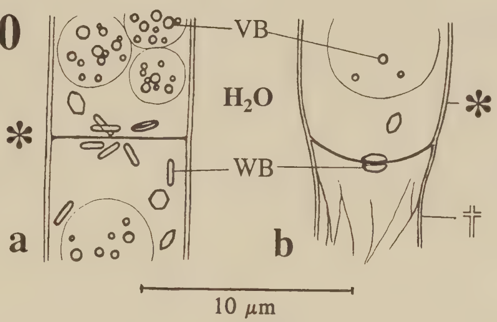
The color of living hymenia may originate from *ectochroic* (= extracellular), *mesochroic* (= cell wall), or *endochroic* (= intracellular) pigments. The first two appear to be typical for long-living discomycetes and are usually unaltered in herbarium specimens. Note, however, that taxonomic problems arise in regard to spore wall pigmentation (see chapter 8). The endochroic pigments are more or less state-dependent and therefore here of special interest: the hymenial color may originate from *cystochroic* (water-soluble, within vacuoles) and/or from *lipochroic* pigments (lipid-soluble, within LBs).

1. Water-soluble pigments (yellow, orange, greenish, bluish or brownish) occur within the VBs of the intact vacuoles of the paraphyses. These pigments may disappear instantaneously (LM, tap water) when cells die during examination in water mounts. On the other hand, a color change of hyaline VBs to yellow, reddish or brownish is often observed and results in deeply colored apothecia which have originally been white. Therefore, HUHTINEN (1990a: 71) describes as *yellow pigment* (often in the dead state) what I differentiate into *hyaline VBs versus yellow VBs* (living state). He consequently merges **Calycellina lachnobrachya** and **C. araneocincta** which have both more or less yellow VBs in the dead state, but differ in the living state (hyaline versus deep yellow VBs; BARAL, 1989b), and occurrence on different hosts. HUHTINEN (l.c.) found, however, that **Hamatocanthoscypha uncipila** is characterized by a yellowish pigment which is *seen clearly only when fresh material is studied in water*.

2. Lipid-soluble yellow to red pigments (carotenoids) occur within globose LBs. These are located in the cytoplasm between the vacuoles, especially in the


red carotenoid crystalloids
WB
WB
orange carotenoid LBs
10 µm
38


39
WB
a
H_2O
*
b
WB
V


40
*
a
VB
H_2O
WB
b
*
╬
10 µm

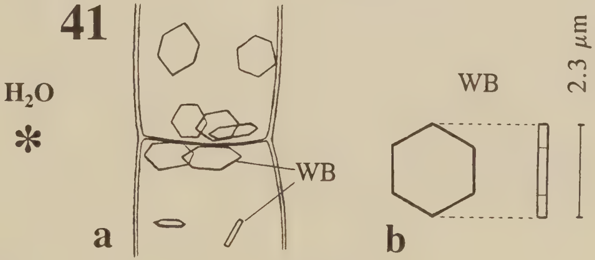

41
H_2O
*
a
WB
WB
b
2.3 µm

FIG. 38. Pigments and WBs in paraphysis of **Scutellinia scutellata**. Carotenoids form elongate red crystalloids towards the apex but occur also within minute orange LBs towards the base. Globose hyaline WBs occur close to the septa. 3000x.

FIGs. 39-41. WBs close to septa of vegetative cells. **FIG. 39. Peziza** spec., **a.** paraphysis, WBs globose, **b.** medullary hyphae, WBs crystalline. **FIG. 40. Discina ancilis** (= **D. perlata**), **a.** paraphysis, WBs form thin hexagonal crystals, **b.** the pore is plugged by the WBs due to the death of the lower cell. **FIG. 41. Verpa digitaliformis**, medullary hypha, WBs forming very large thin hexagonal crystals (not all of the hyphae contain such large WBs). **a.** 3000x, **b.** 6000x.

paraphyses and in the subhymenium. Yet, in some genera the carotenoids form elongate crystalloid structures, possibly due to a high concentration (FIG. 38; HEIM, 1947; ARPIN, 1968: 430). These crystalloids are inert to KOH. Carotenoids tend to completely lose color in dried specimens (ERB, 1972: 10); consequently, the crystalloids disappear while the LBs are stable except for their pigmentation. Presence or absence of carotenoids in fresh specimens of Pezizales is considered a character of high significance (ERB, l.c.). In my experience, **Scutellinia** (FIG. 38) can be distinguished from **Cheilymenia** in most species by the presence of carotenoid crystalloids in the uppermost 2-4 cells of the paraphyses (LBs which contain carotenoids occur in both genera).

In the living fungal cell, the cytoplasm outside vacuoles, is generally (? always) without pigmentation, except for LBs and carotenoid crystals. Yet, in dead cells of species with pigmented exudates one often observes a coloration of the cytoplasm (reddish, olivaceous, bluish, brown, yellow etc.) similar to the exudates. Obviously, a colorless precursor molecule occurs in the living cytoplasm of these species which becomes colored either outside the cell wall by active exudation, or inside the cells as they die. This situation leads to differing reports of cytoplasmic color depending upon the living versus dead state of the cells.

6.f. Nuclei (N)

Nuclei can often be discerned in living unstained cells by their nucleoli (NO) and nuclear membrane (FIGs. 1a, 4, 12-18, 21-26, 35, 42-43) allowing a rapid evaluation of cell nucleation. For example, species of Sclerotiniaceae differ in the number of nuclei per ascospore. Staining *in statu vivo* with IKI usually strongly enhances contrast of the nuclei (CORNER, 1929: 264) whilst CRB_A, applied to living cells, often stains the nucleolus pale blue. Nuclei are indiscernible in dead, unstained cells and shrink considerably as they die (FIG. 12 a→b). CB often stains them a darker blue than the cytoplasm (FIG. 12b).

6.g. Tracti and "nasse apicale"

A tractus to which the spores are attached occurs in several groups (BARAL, 1987b: fig. 17; 1989b: pl. 3, D), e.g. in **Lecanora** (FIG. 9a, perhaps the first report in this genus). A *nasse apicale* was observed in asci of several species of both fissitunicate and unitunicate Ascomycetes (CHADEFAUD, 1942; BARAL, 1987b: figs. 17, 25), e.g. in **Tubeufia** as a quadripartite structure (FIG. 7). The contrast is enhanced by staining *in statu vivo* with IKI, or it is stained greyish by chlorazol black. Tracti are masked in dead asci by the cytoplasm (LM, FIG. 9b), but have been reported in TEM-investigations. The existence of the *nasse apicale* is doubted, e.g., by REYNOLDS (1971) who interpreted CHADEFAUD's structure as striae on the inner surface of the endotunica resulting from the banded pattern of the microfibrils. My observations in both Leotiales and Dothideales, however, clearly indicate that the *nasse apicale* is a cytoplasmic structure able to detach from the endotunica.

6.h. De Bary bubbles (DBBs)

Living cells with non-elastic walls compensate for water loss by (FIG. 11 c-h) wrinkling, by collapsing or, in cells with rigid thick walls, by forming DBBs, a gas of presumably water vapour (INGOLD 1956). DBBs are consistently absent in water mounts of living hydrated spores and soon disappear if dry living spores are rehydrated: dry spores of **Hypoxylon serpens**, collected recently and 15 years ago, when placed in water lose DBBs within about 0.5-2 min. Then, DBBs are rapidly induced anew within about 10-15 sec by adding CB, MLZ etc. to the water mount (see also DODGE, 1957). DBBs are also seen by the common practice of mounting fresh or dried ascocarp fragments directly in CB or MLZ. On boiling MLZ slides of **H. serpens** several times, DBBs do not disappear. They disappear only when the MLZ is removed by water. Likewise, HUHTINEN (1983) found DBBs in various genera to be present in MLZ or heated lactophenol but to disappear by gentle heating of a water, Congo red, or KOH mount.

Yet, after having brought an MLZ or a water mount of **H. serpens** to boiling, it proved impossible to induce DBBs anew by adding MLZ (the heated MLZ must be replaced with water until the DBBs have disappeared), which indicates that heating has killed the spores. Collapsing in MLZ occurred in not fully mature spores of this species, including both living and dead spores. This clearly indicates that, in this species, the spore wall is impermeable to the chloral hydrate of MLZ.

DBBs have been introduced as a taxonomic feature by workers who are used to study herbarium material or to mount in CB, MLZ etc. Those, however, who usually mount fresh ascocarps in water wonder why they never see DBBs. From the above, the formation of DBBs within some seconds by adding MLZ or the like to a water mount can serve as a test for vitality.

7. ALTERATIONS IN THE CHEMICAL REACTIONS

7.a. KOH-reaction of VBs

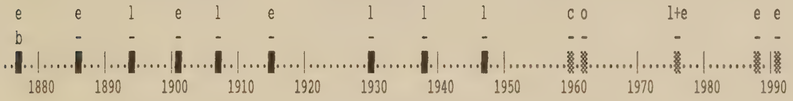
A sulphur-yellow reaction of hyaline VBs to KOH characterizes many mollisiaceous fungi, e.g., **Nimbomollisia eriophori**, **N. melatephroides**, **Mollisia phalaridis**, **Tapesia rosae**, **T. prunicola**, **T. fusca**, **T. hydrophila**, **T. retincola**, **Obtectodiscus aquaticus**. This reaction has been observed in 22 out of the 45 species with VBs so far studied, with some showing variations. SVRČEK's (1986) description of **Mollisia alcalireagens** is mainly based on the yellow KOH reaction, which he thought to be exceptional in this "new species", and thus needs critical revision. The reaction in **Obtectodiscus** supports the idea that this genus is close to the Dermateaceae as was supposed by SCHEUER (1988: 128).

The following method is used: KOH is added to the water mount. The yellow color instantaneously appears around the ascocarp as soon as the KOH reaches the paraphyses, but is rapidly diluted in the medium and soon becomes invisible. The KOH concentration may vary from 2% to 10% while 0.5-1% is much less efficient. The reaction is often absent in senescent ascocarps but was still present in full strength in 0.5 and 4 years old **M. phalaridis** and in 14 years old **T. rosae**. Perhaps, old material fails to react or gives inconsistent results since NANNFELDT (1986: 197) wondered why he could not obtain the reaction in any species. Yet, DENNIS (1950: 182) observed a sulphur-colored KOH reaction in the type material of **M. junciseda** collected in 1868. It is therefore surprising that this reaction has very rarely been reported although KOH is in current use for mounting dried fungi, perhaps because the yellow color had disappeared before the KOH-mount was studied. **Scutomollisia russea** differs in having deep orange VBs which reversibly turn deep violet by KOH.

7.b. Hemiamyloidity

The red (hemiamyloid) reaction of certain wall layers of lichen asci observed in IKI but not in MLZ (BARAL, 1987a; COMMON, 1991: 96) is converted to a uniformly blue reaction not only when KOH-pretreated, but also by preservation in the herbarium for at least about one century (KILIAS, 1981: 256, 410; RAMBOLD, 1989: 37). Conversion from types RR and RB (hemiamyloid) to BB (euamyloid) means that the different types of hemiamyloidity which serve as features of high taxonomic value are irreversibly lost in old herbarium specimens. This conversion is not related to the living versus dead state of the asci. It can now also be reported for the apical rings of the Leotiales:

Tests were made in the summer of 1991 on the genera **Pezicula** and **Ocellaria** (Leotiales), which are defined by apical rings reacting hemiamyloid (type RR). Three species of **Pezicula** and one of **Ocellaria** were studied. 15 collections made between 1877 and 1991 were examined, 11 of which (1877-1963) were received from the Staatsherbarium Munich (M): IKI without KOH-pretreatment gave a red reaction (type RR) in 0-31 years old material, while 44-114 years old material consistently showed a blue reaction which only sometimes turned grey to reddish-grey at a high IKI-concentration. The material in M was repeatedly treated in a freezer (-20°C for 2 h) since about 15 years and poisoned prior to this date (D. TRIEBEL, pers. comm.). This valuable generic feature of **Pezicula** therefore disappears in herbarium specimens much earlier than observations on lichens indicate. The MLZ-reaction without pretreatment was, however, still negative in all collections except for the one from 1877 which reacted MLZ+ pale blue. This situation (blue in 1% IKI but MLZ-) corresponds to that obtained by a weak KOH-pretreatment (BARAL, 1987a: 421, tab. 4) and offers a certain opportunity to recognize hemiamyloidity in old material.



TAB. 2. Iodine reaction (without KOH-pretreatment) of apical rings in 15 collections of **Peziculoideae**, depending on the age of the herbarium material. ▒ = IKI-red, ▌ = IKI-blue. 1st line: l = **P. livida** (asci 8-spored), e = **P. eucrita** (here understood as a 4-spored species), c = **P. cinnamomea**, o = **Ocellaria ocellata**; 2nd line: b = MLZ-pale blue, - = MLZ-negative.

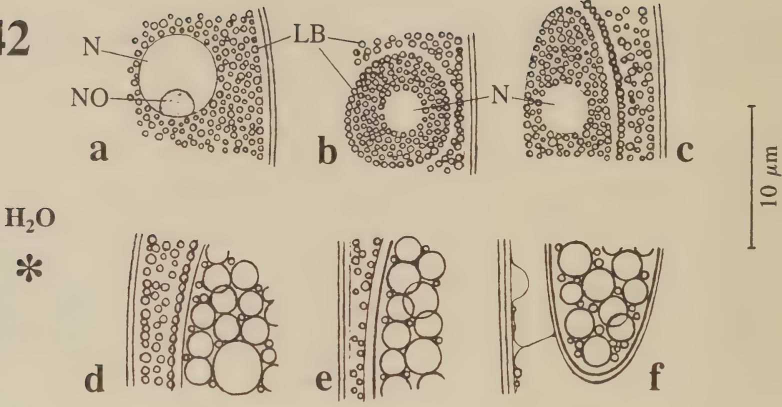
8. ALTERATIONS DEPENDING UPON THE DEVELOPMENT STAGE OF THE CELLS

The development stage of fungal cells can be determined more precisely in the living state. This is of special importance with ascospore characters: number of septa, wall pigmentation, ornamentation, size, and lipid content often markedly differ when comparing the stages of immaturity, maturity, first and second phase of germination. The first phase of germination (GARRAWAY & EVANS, 1984: 221) differs from the stage of maturity by morphological changes, and may either lead directly to the protrusion of a germ tube (second phase of germination), or may persist for a long period of time (dormancy; such spores often show a light brown wall pigmentation though having been hyaline at maturity).

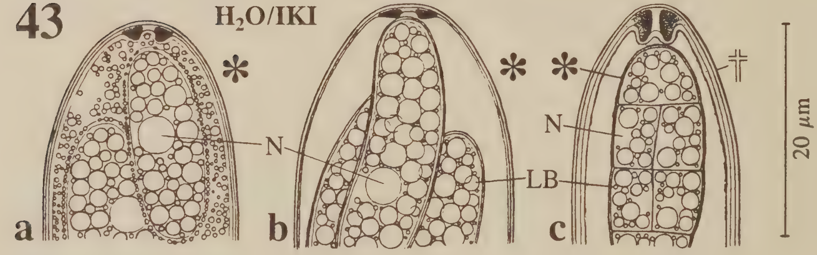
In vital taxonomy, maturity of ascospores can be understood in a very narrow sense: I term ascospores *mature* when actively discharged by the internal pressure of the living ascus, either in a humid atmosphere, or in a water mount during microscopic examination, without applying external pressure. A few hours after natural discharge, however, the spores may already have passed into the first phase of germination, provided that the water mount was protected from evaporation.

BOUDIER (1885: 94) emphasized the fact that spores are often less variable than usually believed when examined in the mature state, i.e. *sorties naturellement de la thèque*. Spore diagnoses should therefore consequently be based on mature spores which have been naturally liberated by explosion of the asci in water mounts. Spore characters in the phases of germination should be evaluated separately and kept apart from those of the mature spore as was done, e.g., by WOLLENWEBER (1939).

42



43



FIGs. 42-43. Ascosporogenesis in **Pezicula**. Note changes in spore width and septation (FIG. 43 b→c), and in lipid content. Living asci are required in order to determine the development stage of spores. Septate spores never occur inside living asci of **Pezicula**. **FIG. 42. P. cinnamomea**, **a.** fusion nucleus, **b.-e.** spore formation, **f.** mature spore; **FIG. 43. P. livida**, **a.** immature spore, **b.** mature spore, **c.** spore in the first phase of germination. FIG. 43 ab from BARAL (1987b). 2000x.

Ascospores are often 1-celled when mature but 2- to multi-celled in the first phase of germination. Thus, in certain species, a collection of young mature apothecia shows consistently 1-celled spores both within and outside asci while a collection of senescent apothecia shows predominantly multi-celled spores. Other taxa, however, show 2- or multi-celled spores already in the stage of maturity. It is therefore unwise to consider spore septation a variable feature with little reliability, as is often done. Usually, there is little variability if we carefully separate the different development stages of ascospores. This is only possible if we study living asci and ascospores.

The species of **Pezicula** discharge their spores consistently in the 1-celled stage while muriform spores occur only in the germination phase (FIG. 43). Likewise, **Velutarina rufoolivacea** discharges consistently hyaline spores. These may later become brown (delayed pigmentation), either outside asci or within dead asci but never within living asci. Other taxa, however, have septate, or brown spores inside mature living asci.

A further example is the phenomenon of ascosporal phialidic conidia born directly on ascospores: The term *ascoconidia* has often been misapplied to conidia produced inside dead asci by the budding of ascospores; it should be restricted to conidia which are produced from ascospores in a premature stage of development of the ascus (true secondary polyspory). Ascoconidia are actively discharged in aggregations of 4-8 "balls" which at first glance simulate mature ascospores (FIG. 10a). BREFELD (1891: 293, pl. XI, fig. 41,3) described these balls in **Tympanis truncatula**. Species of **Claussenomyces** can easily be divided into two larger groups, one with true ascoconidia (e.g., **C. olivaceus**), the other with conidia produced only on ascospores outside asci or within dead asci but never within living asci (e.g., **C. prasinulus**). Likewise, **Tympanis**, **Rhamphoria** and **Nectria coryli** produce ascoconidia, while, e.g., **Ascocoryne** and **Pezicula** produce conidia only on ascospores following natural discharge or within dead asci, and are therefore not polysporous. MARTENS (1936: 385) wrongly considered the asci of **C. prasinulus** and **Ascocoryne cylichnium** as secondarily polysporous. Likewise, HAFELLNER & BELLEMÈRE (1983) were unable to distinguish between true secondary polyspory and conidia produced on naturally discharged ascospores. They reported conidial formation within (dead) asci of **Brigantiaea**, leaving the question open whether or not the spores are ejected prior to budding.

Since fresh ascocarps mostly contain both living and dead asci, and since it is impossible to see from the dead specimen which asci have been alive before desiccation, one is completely unable with herbarium material to decide whether true ascoconidia were present, or whether the spores were hyaline or brown, 1-celled or septate in the mature living ascus. Thus, taxonomists working only with herbarium material are often not prepared to refer such a "variation" to certain development stages of the spores. HAFELLNER & BELLEMÈRE (1983: 175) and HUHTINEN (1990a: 70) have stressed this problem: the authors were only able to consider intuitively "good-looking" spores as "mature", and to ignore "bad-looking" spores as "very old" or "senescent". This subjective method, however, leads, in my experience, to unreliable results.

When drying discomycetes for the herbarium, we should be aware that the dry air often induces most of the mature asci to shoot their mature spores, which represent the standard condition for spore descriptions, rapidly into the air. Herbarium specimens then exhibit predominantly immature spores within the asci, or discharged spores in different phases of germination lying on the hymenium, although the apothecia showed full maturity when collected.

The precise development stage can be recognized by the appearance of the living cytoplasm of spores and asci: immature asci show many small vacuoles and hydrated cytoplasm (FIGs. 15ab, 16ab; CHADEFAUD, 1938), which may contain many small LBs in the *pars sporifera* (FIGs. 42 a-e, 43a); CRB induces the formation of MCs in these vacuoles (FIG. 4). The cytoplasm of the spores shows an increase in number and/or size of LBs during sporogenesis (FIGs. 15, 16, 42 c→d; see also JOHNSON, 1963). Mature asci show strongly dehydrated cytoplasm and a high percentage of "free space" represented by one large vacuole which is filled with transparent water (FIGs. 8a, 9a, 10a, 19, 20, 43b); CRB gives a homogeneous violet stain to the large vacuole, while no MCs are formed; the *pars sporifera* reaches its minimum length.

9. DROUGHT TOLERANCE (= POIKILOHYDRY)

When herbarium material collected within the last few years is studied in water mounts, living cells may still be met along with dead cells in a quantity of species. Spores, especially, are known to survive in some cases for many years (SUSSMAN, 1968). Drought tolerance of fruit-bodies is well-known in a few Agaricales and in many Polyporales and Tremellales (INGOLD, 1986: 578).

Fungal cells usually lose a considerable amount of water when passing into the dry, dormant (still living) state. We must therefore distinguish between *in statu vivo* (living state) versus *in statu emortuo* (dead state) on the one hand, and *in statu umido/udo* (hydrated or moist state) versus *in statu sicco* (dry state) on the other hand. Only few fungi perform a strategy of drought avoidance (e.g. **Daldinia**; INGOLD, 1954: 101). In most pyrenomycetes I found little or no structural check on evaporation: the hymenium desiccates and recovers repeatedly, and the perithecial cavities are completely filled with air in the dried dormant state.

Since vitality of single ascocarp cells can easily be recognized under the LM, I carried out tests on tolerance to dehydration: asci and paraphyses of some selected species of Leotiales and Pezizales did not survive even a few minutes or hours in the dry-air conditions of the herbarium while others survived several months. About 50% of either asci or paraphyses were found to be viable after preservation *in statu sicco* at 18-25°C and about 60% relative humidity for the following period of time: (paraphyses {P} were often more tolerant than immature asci, and these more than mature asci {A})

<1 day: **Ciboria caucus** {AP}, **Peziza succosa** {AP}, **Hymenoscyphus fructigenus** {AP}, **H. rhodoleucus** {AP}, **Ombrophila violacea** {AP}

1-2 days: **Lachnum pudicellum** {A}, **L. subvirgineum** {AP}, **Dasyscyphella nivea** {A}, **Sarcoscypha coccinea** {P}

1-2 weeks: **Trichopeziza mollissima** {AP}, **Brunnipila clandestina** {AP}, **Dasyscyphella crystallina** {P}

3-5 months: **Encoelia furfuracea** {AP}, **Lachnellula occidentalis** {P}, **Capitotricha rubi** {P}
8 months: **Lecanora conizaeoides** {AP}

INGOLD (1954: 97) erroneously assumed that fungal spores are "normally without vacuoles" and therefore drought-tolerant. From the above we must conclude, however, that even cells with large vacuoles (asci, paraphyses) are able to withstand strong and prolonged desiccation. Small vacuoles are often present in mature spores (FIGs. 34-37). From the results on paraphyses, I conclude that even wall thickness is unimportant for a cell to be drought-tolerant.

Fungal cells, including mature spores, mostly have very high water contents (60-90%; READ et al., 1982: 2072) in the state of full vitality and hydration (if ample external water is available). Measurements of low total water contents in spores (YARWOOD, 1950; SUSSMAN, 1968; 5-25% for conidia and ascospores) refer to spores which have been in equilibrium with the dry laboratory environment (*in statu sicco*, 22-24°C, 42-51% relative humidity). The spores have *probably lost a considerable portion of their water in the process of collection* (YARWOOD, l.c., often by collapsing), having thereby passed into a state of dormancy. *Naturally collapsed, viable fungal spores are probably of common occurrence in nature* (BECKETT et al., 1984: 94), owing to their inability to check evaporation. *On wetting, they imbibe water and rapidly swell* by regaining their original size (BECKETT et al., 1984: 87). This phenomenon of low water content is called *anhydrobiosis*. SUSSMAN (1966: 740) believed that anhydrobiosis plays no major role in the dormancy of fungal spores, probably because he thought the wall of the mature spore to be quite impermeable to water.

10. CONCLUSIONS

Studying dead cells from fungi preserved in herbaria has very often led to erroneous taxonomic conclusions. It means disregarding many features of high taxonomic importance which have become obscure or have completely disappeared during the death of the cells. Being unaware of the numerous method-induced alterations presented in this paper means working with incompatible observations made on different states or development stages of the cells. Many taxa, even on generic level (e.g. **Mollisia** s.l. versus **Pyrenopeziza** s.l.), are easily distinguished with fresh material but can often hardly be recognized in the dead state.

Many published theories on ascus function and the mechanism of spore discharge which were based on the study of dead asci turned out to be in part erroneous, while DE BARY's (1887) observations on living asci have still high importance and validity. TEM-investigations should routinely be accompanied by LM-studies of the living cell in order to be aware of the changes affecting both cell wall and cytoplasm.

If taxa concepts have been worked out on the basis of abundant fresh collections, as I have done, e.g., in the "**Sarcoscypha coccinea**-complex" (BARAL 1984), one is more or less able to recognize these taxa also from dried material on the basis of correlated features being unaffected by the death of the fruit-body. Yet the process of getting new ideas and arriving at new taxonomic concepts heavily depends upon the applied method: the species of **Sarcoscypha** clearly differ in the size of the lipid bodies inside the living mature ascospores (FIGs. 23-26, the numerous minute accessory LBs occur in all 4 species). This is the most conspicuous feature in that group (apart from striking ecological differences) which independently led BOUDIER and me to the idea that different taxa are involved. In a part of the dead spores of all these species, however, the lipid forms large variable aggregations of comparable size, so this distinction is strongly obscured. HARRINGTON (1990: 436) confirmed this experience: *although I had examined material (dried herbarium specimens) from western North America I was not prepared to recognize that group as a species distinct from the two, large eastern North American species until I saw fresh (living) material.* LE GAL (1941) was unable to distinguish between **S. jurana** and **S. coccinea** in European material because she studied only herbarium specimens.

Those who are not skilled in recognizing vitality of single cells may even be unimpressed when examining cell contents of fresh specimens because, very often, living and dead cells can be found in a single preparation. Thus, one observes a broad scope of morphological and cytological "variation". BOUDIER (1886: 143) stressed this *relative variability* concerning lipid bodies in spores, a variability which is only manifest if one does not carefully separate living from dead cells, and mature cells from those in other development stages.

I have now studied about 9000 collections of Ascomycetes in the fresh, living state (nearly all of them were admittedly collected in Central Europe), and a further 900 in the dried, mainly dead state. Personal communications revealed, however, that mycologists usually consider that, for various reasons, they are not always able to study a major portion of their specimens in the living state. *A monographer receives material from all over the world, most of which is in the dead dried state. It is mainly his personal collecting effort that will enable him to study fresh material* (S. HUHTINEN, in litt.). Some monographers have not even macroscopically seen some or most of their treated species in the fresh state. The method of studying fungi preserved in herbaria seems fairly convenient and highly advantageous at first sight due to the possibility of comparing critical taxa simultaneously. The present study, however, presents a lot of arguments for a precise taxonomy based on the study of living cells. The results obtained by this method are considered so superior and the conflicts resulting from ignorance of the facts presented here are so important, that it is urgent for everybody to reflect on the methods practiced so far. Even describing "clear" new species which are thought to be easily recognizable from persistent characters is of limited taxonomic value since critical unknown taxa close to every such "clear" taxon may be discovered in the near future.

Vital taxonomy means to be ready for study whenever a species is collected or is received from a colleague by post. Ascomycetes, or even Basidiomycetes (KOIVURINTA, 1978), can be stored in the refrigerator at about +5-10°C for several days or even weeks without any ill effects. The great value of vital taxonomy is that a relatively large amount of microscopic data can be gathered in a reasonable period of time and with higher efficiency concerning the value of the results. SVRČEK (1976: 116) wrote: *In fact, the study of dried specimens as such is much more difficult and more time-consuming than work with fresh material.* Furthermore, vital taxonomy means frequent and regular field work. Herbarium taxonomy has resulted in a deficiency in our knowledge of ecological preferences of a species. Many species are known only from the type collection, the host on which they grew being often unknown, and many species are said to be difficult to find. The experience of G. MARSON (pers. comm.) and me is, however, that many species are of more common occurrence and are consequently available for a study *in statu vivo* at a much higher frequency than is usually believed.

A problem arises in the typification of taxa being mainly distinguished by transitory characters (which are only visible in the living state). According to Art. 9.1, ICBN (GREUTER et al., 1988), the type of a species must be a dried specimen or microscope slide). Living plants or cultures are not permitted (Art. 9.5, ICBN). Illustrations rank second and are only accepted as types if specimens are lacking or cannot be preserved as dried specimens (Art. 9.3, ICBN). This method requires the recognition of the species from the dead state. Should we therefore consider characters which are visible only in the living fungus to be less valuable for taxonomic purposes?

According to BRESINSKY (1964), exsiccata especially in Agaricales, exhibit much less distinctive macroscopical differences when compared with the living basidiocarp. In order to emphasize the value of microscopic features in this group and to facilitate the study of type material, he produced keys to exsiccata which either allow the determination of species, or only taxa of somewhat higher level. I suppose, however, that these keys are predominantly based on pre-existing taxa concepts which had been prepared on the basis of macroscopical characters of fresh, living basidiocarps. Thus, ORTON (1960: 161) recommended to study fresh Agaricales and Boletales both *macro- and microscopically, before pronouncing a verdict on the dried material.* Concerning the Pezizales, BENEDIX (1972: 163) stated that dried material alone is insufficient for taxonomic decisions on critical, mainly macroscopically defined species.

Nevertheless, monographers have probably very often prepared their taxa concepts on the basis of dried material. In the higher plants, for example, LEENHOUTS (1968: 26ff.) recommended to find out taxonomical entities by carefully comparing a large number of herbarium specimens ("herbarium taxonomy").

We have to acknowledge that dried specimens do not reflect either the macro- or the micromorphology of the living state. Since there exist many state-dependent features, it is necessary to describe these features from living cells in water and note anomalies caused by the death of the cells or by reactions to mountants (this was also recommended by Spain, 1990: 75). No satisfactory method for the fixation of transitory characters for permanent preparations is known. According to Read et al. (1982), *all preparative procedures that all necessitate the elimination of constituent water used in SEM produced artifacts*. It is therefore highly desirable that drawings, photographs, and descriptions of living fungal organs are deposited together with the dried specimens. Microscopic measurements should mainly be taken from living cells in water (although these data are incompatible with those obtained from herbarium material) since the stage of development of the organs cannot clearly be recognized after mounting in lethal media (Note that Huhtinen, 1990, gave measurements of spores and asci, whenever possible, *when fresh in water* along with those in MLZ or CB).

In order to prepare more precise taxonomic concepts, both extended field work and immediate microscopic study is necessary. Monographers are urged to make as many personal fresh collections as possible. Due to the substantial loss of valuable vital characters in dead fungi, descriptions of type material *in statu vivo* have high importance. If an Ascomycete taxon cannot satisfactorily be recognized from dried specimens, the protologue, if based on living specimens, must automatically rank first in the typification of its basionym. New taxa should therefore be described from living specimens whenever possible.

11. HOW TO MAKE VITAL TAXONOMY

11.a. Method

1. How to collect:
 - drought-intolerant Ascomycetes:
   - use boxes of watertight material (no paper boxes)
   - produce a humid atmosphere inside by adding fresh moss etc.
   - avoid mechanical pressure
 - drought-tolerant Ascomycetes:
   - can be collected in dry or fresh condition
   - rehydrate dry fruit-bodies a few minutes prior to preparation by spraying with water
2. How to make preparations for the LM:
   - mount in tap water
   - avoid long-time exposure of ascocarps to dry air or warm light
   - place the fungal fragment immediately into the water drop on the microscope slide in order to avoid critical desiccation
   - cut freehand through the hydrated ascocarp under the dissecting microscope
   - stain *in statu vivo* by adding CRB or IKI to the edge of the coverglass

- add toxic (lethal) reagents to the edge of the cover glass to observe alterations
- note whether each described cell was alive or dead
- employ (osmotically inert) viscous solutions of albumin for photomicrography in order to prevent movement of spores
- keep immature collections for some days in the box to obtain mature hymenia
- allow some apothecia to deteriorate in order to study ascospore germination and possible production of conidia on the ascospores

11.b. Important vital characters

1. Asci:
   - measure living, mature asci first because these readily liberate the spores in many genera
   - observe presence or absence of croziers which can readily be seen in sections of living young apothecia (apply no pressure on the coverglass!)
   - study the apical apparatus prior to discharge in both the living and the dead state; employ IKI for diagnosing blue versus red reactions

2. Spores:
   - take measurements and observe spore characters from living mature spores recently shot into the medium by active spore discharge (spores inside living asci are often distinctly narrower though mature due to the ascus turgor, and spore characters like pigmentation, septation etc. strongly depend upon the development stage)

3. Sterile tissue:
   - study excipular structures from living sections which are not too thin (approx. 30-100 μm)
   - recognize imbibition of water by intercellular gel in the dead state when applying CB or MLZ to the section (textura oblita in the dead state may look like textura prismatica in the living state!)
   - observe cell contents in living paraphyses, hairs, and excipular cells, especially properties of the VBs: refraction, shape, size, color, location

11.c. How to study dead herbarium specimens

- use water first in order to prohibit dissolution of wall deposites or exudates, and to test the IKI reaction for hemiamyloidity
- use 2% KOH for the observation of the lipid in the cells, especially in the spores (the lipid in dead cells is often masked in nearly all other

mountants in use)
- the ascogenous hyphae can be studied for croziers by mounting in KOH or in Congo red (strong pressure on the coverglass and heating may be necessary)

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NOTEWORTHY SPECIES OF *COLLYBIA* FROM MEXICO AND A DISCUSSION OF THE KNOWN MEXICAN SPECIES

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SUMMARY

A check list of the 20 reported species of ***Collybia*** from Mexico since 1910 is presented, of which 4 belong to other genera. The differences between ***Collybia alkalivirens*** Sing. and ***C. fuscopurpurea*** (Pers. : Fr.) Kumm. are discussed. New localities are presented from the States of Morelos, Oaxaca, Tlaxcala, and Veracruz for the former, and from the States of Mexico, Nuevo León, and Veracruz for the latter. ***C. alkalivirens*** is distinguished by the smaller spores and coarse incrusted hyphae of both lamellar and stipe tramas, and ***C. fuscopurpurea*** by its larger spores, and punctate hyphae in the lamellar trama and coarsely incrusted on the stipe trama. New localities from the States of Hidalgo, Oaxaca, Tamaulipas and Veracruz of ***C. iocephala*** (B. & C.) Sing. are presented. Moreover ***C. polyphylla*** (Peck) Sing. ex Halling and ***C. butyracea*** (Bull. : Fr.) Kumm. are described; they have a widespread distribution in the country but have not been studied microscopically.

RESUMEN

Se presenta una lista de las 20 especies de ***Collybia*** registradas en México, desde 1910 al presente, de las cuales 4 se adscriben a otros géneros. Se discuten las diferencias entre ***Collybia alkalivirens*** Sing. y ***C. fuscopurpurea*** (Pers. : Fr.) Kumm. y se dan nuevas localidades de los Estados de Morelos, Oaxaca, Tlaxcala y Veracruz para la primera y de los Estados de México, Nuevo

León y Veracruz para la segunda. ***C. alkalivirens*** se distingue por sus esporas pequeñas y por las incrustaciones grandes en las hifas tanto de la trama laminar como en del estípite y ***C. fuscopurpurea*** tiene esporas grandes, hifas de la trama laminar solamente punteadas y las hifas de la trama del estípite fuertemente granulosas. Se presentan nuevas localidades de ***C. iocephala*** (B. & C.) Sing. de los Estados de Hidalgo, Oaxaca, Tamaulipas y Veracruz y descripciones de ***C. polyphylla*** (Peck) Sing. ex Halling y ***C. butyracea*** (Bull. : Fr.) Kumm., especies de amplia distribución en el país, pero que no habían sido estudiadas microscópicamente.

INTRODUCTION

A revision of species of ***Collybia*** collected in forests of the State of Veracruz by the authors and several exsicati identified as ***Collybia alkalivirens*** Sing. in XAL, FCME and ENCB herbaria was made. Some of the materials could be ascribed to that species concept, mainly because of the instantaneous green reaction with 5% KOH and by hymenial and stipe hyphal incrustations as observed in water. Other collections discussed below did not fit this species concept and agree with ***C. fuscopurpurea*** (Pers. : Fr.) Kumm.

Also it was noted that ***C. polyphylla*** (Peck) Sing. ex Halling and ***C. butyracea*** (Bull.: Fr.) Kumm. are poorly known in Mexico, in spite of their widespread distribution, and ***C. iocephala*** (Berk. & Curt.) Sing., previously studied by the authors (Montoya-Bello *et al.*, **1987**) is reported from new localities.

Considering the present status of the genus in Mexico, it was concluded that a revision of the known species of ***Collybia*** in Mexico is needed, and this is a first attempt towards the analysis of the genus in the country. Microscopic mounts were made in 5 % KOH, congo red, cotton blue and water.

SPECIES OF *COLLYBIA* REPORTED FROM MEXICO

Table 1

Murrill (**1910**, **1915**, **1916**) was the first to study ***Collybia*** (most of them as ***Gymnopus***) from Mexico. He considered ***C. dryophila*** (Bull. : Fr.) Kumm., ***C. fimetaria*** (Murr.) Murr., ***C.***

orizabensis (Murr.) Murr., ***C. roseilivida*** (Murr.) Murr., ***C. velutipes*** (Curt.: Fr.) Kumm. and ***C. xuchilensis*** (Murr.) Murr., of which the second and the two latter species are now placed in ***Mycena***, ***Flammulina*** and ***Hydropus***, respectively. On the other hand, ***C. orizabensis*** and ***C. roseilivida*** are known only from Mexico. Murrill (1915) also described ***Marasmius subcyathiformis*** Murr., which Pegler (1977) considered as ***Collybia subcyathiformis*** (Murr.) Pegler.

Sharp (**1948**), Guzmán (**1961**, **1972**, **1977**), Welden *et al.* (**1979**) and Martínez-Alfaro *et al.* (**1983**) recorded several additional species of ***Collybia*** . Table I presents the 20 species reported from Mexico from 1910 to 1990. As previously noted, 3 of them are actually in other genera and ***C. platyphylla*** reported by Sharp (**1948**) is treated in ***Tricholomopsis*** following Singer (1986) or also in ***Oudemansiella*** or ***Megacollybia*** following others.

At present only 16 species of ***Collybia*** are known to ocurr in Mexico, but a critical taxonomic study is necessary, because some of them are not treated in the modern concept of the genus, i.e. example, ***C. roseilivida*** (Murr.) Murr. should be a ***Mycena*** in the modern sense, and others are known only from the type specimens. Moreover, ***C. peronata*** (Bolt. : Fr.) Kumm. seems to be represented in the New World by three taxa involved (Halling, pers. comm.)

Among the most common species considered in Mexican literature are ***C. dryophila***, ***C. polyphylla***, ***C. butyracea***, ***C. confluens*** (Pers. : Fr.) Kumm. and ***C. maculata*** (Fr.) Kumm., which are distributed mainly in temperate forests of the country (Guzmán, **1977**).

NEW RECORDS OF *COLLYBIA ALKALIVIRENS*

Figs. 1-9 & 20-21

Collybia alkalivirens is easily distinguished by the green reaction of all parts of the basidiocarp in contact with KOH, and also by the brown hyphal incrustations of the pileal, hymenial, and stipital tramas observed in water or in Melzer's solution. Specimens examined had spores (4-) 5-8 (-9) x (2.4-) 3.2-4 (-4.8) µm and polymorphic cheilocystidia (15-)20-80 x 3-9 (-11) µm, light brown to yellowish brown in water, and stain green with KOH. The same staining reaction with KOH was observed in caulocystidia [29-54 x 4-6 (-10) µm] and in the hymenium and stipe hyphae.

The six Mexican studied materials, agree well with the descriptions of Halling (**1979**, **1981**, **1983**) and also with two collections from the U.S.A. identified by him (Halling 3726, New York, Tomkins Co., and Halling 4425, from Massachusetts, Franklin Co., both at NY).

For the differences between ***C. alkalivirens*** and ***C. fuscopurpurea*** see a discussion below. This species was originally described from a deciduous forest in the U.S.A. (Singer, **1948**). In Mexico it has been reported from temperate forests (Guzmán, **1977**), particularly from the States of Durango (Quintos *et al.*, **1984**) and Morelos (López *et al.*, **1985**). Here it is recorded from five new localities in *Pinus-Quercus*, mesophytic (subtropical) and *Abies religiosa* (H.B.K.) Schl. & Cham. forests.

Material studied. STATE OF MEXICO: Parque Nacional Nevado de Toluca, junction of the roads Temascaltepec-Sultepec, Colón 56 (ENCB). STATE OF MORELOS: km 55 old road from Tres Marías to Cuernavaca, Colonia Atlixco, Guzmán 5681; 12104 (ENCB). OAXACA: San Pedro Macuiltianguis, Alvar González, s.n., Jun. 5, 1984 (XAL, IBUG). STATE OF TLAXCALA: Municipio de Ixtenco, Parque Nacional La Malintzi, ladera Xalapasco, González-Fuentes 983 (XAL, FCME). STATE OF VERACRUZ: Cofre de Perote Region, Municipio de Xico, N of Ingenio El Rosario, Los Gallos, Villarreal 2892 (XAL).

ADDITIONS TO THE KNOWLEDGE OF *COLLYBIA FUSCOPURPUREA*

Figs. 10-19 & 22-23

Collybia fuscopurpurea (Pers. : Fr.)Kumm. was redescribed recently by Halling (**1990**) based on materials from Europe, the U.S.A., and a collection made by Singer in Mexico (Region of Río Frío). Coincidental with Halling's study, the authors of the present paper were studying some Mexican materials related to ***C. alkalivirens*** which tentatively were considered to be a new species, but later it was concluded that the materials agree well with ***C. fuscopurpurea***.

Halling differentiated ***C. fuscopurpurea*** from ***C. alkalivirens***, by spore size and by the geographical distribution. The former grows in the U.S.A. Rocky Mountains during Autumn, and the latter grows in the east of the Great Plains in early Summer. The distribution and seasonal influence in the U.S.A. cannot be applied to Mexico. But in addition to spore size, the hyphal incrustations is another good microscopic feature to separate the species.

C. fuscopurpurea have the hymenial trama hyphae slightly but constantly granulose, or just punctated, and those of the stipe trama have big granular incrustations (figs. 22 & 23), in contrast with ***C. alkalivirens*** having both stipe and hymenial trama hyphae distinctly ornamented with big granulose incrustations (figs. 20 & 21). These features were also observed in material of ***C. fuscopurpurea*** collected by Halling from Belgium (Halling 4888, Prov. Namir Bois Resteigne, at NY). However a collection studied by Halling (Desjardin 464, from California, Marin Co., Lake Bon Tempe, at NY) and considered by Halling (**1990**) as ***C. fuscopurpurea***, presents features which relate it with ***C. alkalivirens*** (medium size spores and both stipe and hymenial trama hypha strongly granulose). Then the size of the hyphal incrustations is a good feature to separate ***C. fuscopurea*** from ***C. alkalivirens***, because is a constant feature, as the authors observed in the several studied specimens of both species.

Mexican materials of ***C. fuscopurpurea*** studied by the authors present the following characters:

Pileus (5-) 10-30 (-40) mm diam., convex to nearly plane or subumbilicate, smooth, margin translucent striate, lubricous, hygrophanous, dark reddish brown to reddish straw or cinnamon color, with irregular blackish stains. Lamellae subdecurrent to adnexed, subdistant, more or less thick and wide, sometimes intervenose, concolorous with the pileus or light chocolate brown color to blackish in the dried state. Stipe 40-70 x 1-3 (-4) mm, uniform, sometimes applanate, fibrillose, slightly longitudinally sulcate, smooth or slightly pruinose mainly at the base, concolorous with pileus or vinaceous red, to nearly black in the dried state. Context whitish to reddish brown, thin and subleathery, odor and taste mild. Surfaces instantaneously green olivaceous in contact with KOH.

Spores (5-) 6.4-9 (-10) x 3-4.8 (-5) µm, lacrymoid or subellipsoid, hyaline or pale yellowish in KOH and in water, inamyloid. Basidia 24-30.4 x 4.8-6.4 µm, tetrasporic, hyaline, clavate, frequently clamped at the base. Pleurocystidia lacking. Cheilocystidia (14-) 18-45 (-60) x 4-6 (-8) µm, numerous, cylindric, flexuous, irregularly lobulated, sometimes apically dichotomously or trichotomously lobulated, hyaline, yellowish or yellowish brown in water and greenish in KOH, frequently clamped at the base. Caulocystidia 22-65 (-90) x 3-5 µm, common, cylindric, flexuous, sometimes irregularly lobulated, similar in color to cheilocystidia. Pileus cuticle not gelatinous; elements (3-) 5-8 (-10) µm wide, subglobose, short and irregularly bifurcate, not radially arranged, punctate, incrustations brown when observed in water. Pileus context with hyphae 3.2-4.8 µm wide, hyaline or yellowish in water, sometimes with short granulations observed in water. Hymenial trama subregular; hyphae (3-) 4-10 (-16) µm wide, yellowish to yellowish brown when observed in water, brown in mass, with very short and obscurely conspicuous granulations when observed in water. Stipe hyphae (3-) 5-15 (-18) µm wide, hyaline to yellowish in water, surface covered with very distinct strong granulations (bigger than those of the hymenial and pileus trama), brown when observed in water. All granulations mentioned above, disappear in contact with KOH and hyphae appear smooth and stain greenish. Clamp connections common.

Habitat and distribution of Mexican materials. Common in humus in coniferous forests composed of ***Pinus patula*** Schl. & Cham., ***P. montezumae*** Gord., ***P. hartwegii*** Lindl. and other species or of ***Pseudotsuga macrolepis*** Flous. It is known from the States of Mexico, Veracruz and Nuevo León.

Material studied. STATE OF MEXICO: road Mexico to Puebla, Río Frío Region, Parque Nacional Llano Grande, Guzmán 7516; Frias-Neve 37 (both in ENCB). Parque Nacional Nevado de Toluca, km 16.5 carretera a Sultepec, Rancho Casas Viejas, Colón 705

(ENCB; XAL). STATE OF NUEVO LEON: Municipio de Galeana, road 18 de marzo to Torre de Microondas, Cerro El Potosí, Girón 19; Galván 230 (both in ENCB). STATE OF VERACRUZ: Cofre de Perote Region, 1 km S of Tembladeras, El Revolcadero, Villarreal 421, 429, 1866, 2404-C (all in XAL).

Halling (**1990**) described the species with spores 6.7-8.5 x 3.3-4.8 μm, pleurocystidia absent, cheilocystidia 20-25 μm long, hymenial trama hypha with scattered brown encustring pigment, pileus trama hyphae 5-10 μm wide, with "granular encrusting pigment" and caulocystidia 3.5-7 μm diam. In the material from Belgium (Halling 4888 NY) the present authors found spores 6.4-8.8(-9.6) x 3.2-4.8 μm, cheilocystidia similar to Mexican materials, hymenial trama hyphae punctate or with fine granulose incrustations and stipe hyphae with big granulose incrustations. Therefore, Mexican specimens fit the European concept of this species.

NEW LOCALITIES OF *COLLYBIA IOCEPHALA*

This species is characterized by the distinct violet color of basidiocarps, also by its strong odor which resembles that of garlic or gunpowder and by the instantaneous blue turquoise reaction of the surfaces in contact with KOH, which can also be demonstrated in the dried state. The pileipellis is a layer of cylindric hyphae radially arranged, 3-4(-5) μm wide (figs. 24-25), which distinguish this species of those of alkalivirens group, which present analogous reaction in contact with KOH, but have short, subglobose and irregularly bifurcate pileus hyphae not radially disposed.

Collybia iocephala is common in deciduous and subtropical forests in the U.S.A. including Florida (Halling, **1983**). In Mexico, it is known from tropical rain forests (in Uxpanapa region) to the mesophytic (subtropical) forests in SE of the State of Veracruz (Welden *et al.*, **1979**; Montoya-Bello *et al.*, **1987**). Five new records of this species are reported. They were collected in mesophytic forests in the States of Veracruz (central part), Hidalgo and Tamaulipas.

Material studied. STATE OF HIDALGO: Municipio de Molango, Laguna Atesca, Cifuentes 675 (FCME, XAL). STATE OF OAXACA: SE de Huautla de Jiménez, San Agustín, Vargas 253

(ENCB). STATE OF TAMAULIPAS: Municipio de Gómez Farías, Reserva de la Biósfera El Cielo, Bandala 1436 (ITCV). STATE OF VERACRUZ: 2 km SW from Xalapa, near Coapexpan River, Bandala, 1369 (XAL), 1333 (XAL, IBUG), 1345 (XAL, ENCB). Municipio de Banderilla, SW Banderilla, Cerro La Martinica, Montoya 549 (XAL, FCME), Rancho La Pomarrosa, Anell 394 (XAL). Old road Xalapa-Coatepec, km 2.5, Casa Asistencial CONECALLI-DIF, Ochoa 28 ; Murrieta 12, 477; Tapia 594, 643; same road, Parque Ecológico Francisco J. Clavijero, Anell 484, 434, Montoya 1295; Mata 325; El Haya, Bandala 1536 (all in XAL).

COLLYBIA POLYPHYLLA IN MEXICO

Figs. 26-28

Collybia polyphylla is widespread in Mexico (Guzmán, **1977**; Bandala *et al.*, **1988**), but still has not been studied microscopically in the country and as noted in herbaria materials it has been commonly missunderstood with ***C. dryophila***, but they differ microscopically and by the strong odor of garlic in the former.

Mexican materials have the following microscopic fectures: spores (3.2-) 4-6.4 (-7.2) x 2.4-3.2 (-4) μm, cylindric-elliptic, inamyloid, asymmetric, with a conspicuous hilar appendix. Basidia 16-24 x 5.6-6.4 μm, tetrasporic, sometimes bisporic, clavate, frequently clamped at the base. Pleurocystidia absent. Cheilocystidia (16-)20-56 (-72) x (2.4-) 3.2-5.6 μm, numerous, but obscurely conspicuous, hyaline, irregularly cylindric-flexuous, irregularly ramified with long or short prolongations, clamped at the base. Hymenial trama with parallel hyphae, 4-11.2 μm diam., thin walled and clamped. Pileus hyphae more or less parallel to the surface and radially oriented, hyphae 3.2-9.6 (-11.2) μm, hyaline, thin walled, clamped, with subcylindric, irregularly ramified or bifurcate elements, which are sometimes erect.

The materials studied agree well with the description of Halling (**1983**), who described the species with spores 5.6-7(-7.6) x 2.8-3.4(-4.4) μm and cheilocystidia 35-56 μm long. Halling recorded ***C. polyphylla*** from eastern deciduous forests of the U.S.A.

Habitat and distribution. Subgregarious in humus, in *Pinus-Abies* or in subtropical and tropical forests, from nearly sea level to mountains at 3000 m altitude. It has been reported from the States of Durango, Hidalgo, Jalisco, Michoacan, Morelos, Quintana Roo and Veracruz.

Material studied. STATE OF VERACRUZ, Cofre de Perote Region, Municipio de Xico, N of Ingenio El Rosario, Los Gallos, Murrieta 2, 24; Bandala 71, 1859; Montoya 1935, 1636; Chacón 4226, 4227, 4252, 4269; Villarreal 405, 1876 (all in XAL).

COLLYBIA BUTYRACEA IN MEXICO

Figs. 29-31

This species has commonly been considered in Mexican literature (Guzmán, **1977**; Bandala *et al*, **1988**) but like ***C. polyphylla***, Mexican specimens have not been studied microscopically and frequently have been missunderstood with ***C. dryophila***, as noted in herbaria materials. The species is common in coniferous and ***Quercus*** forests, and is sold in popular markets. It can be distinguished from ***C. dryophila*** by the lubricous or oily and fleshy pileus, and by the rosy cream spore print, unramified pileipellis hyphae as well as by the cyanophilous and dextrinoid spores. The Mexican specimens agree with Halling's description (1983).

The material studied have spores (4.8-) 6.4-8 x (2.4-) 3.2-4 µm, subelliptic, with an acute asymmetric appendix, hyaline, cyanophilous and dextrinoid, appearing surrounded except at apex by a sheet when observed in Melzer's solution, in congo red or sometimes in KOH. Basidia 21.6-25.6 x 4.4-6.4 µm, tetrasporic, hyaline, clavate, frequently clamped at the base. Pleurocystidia absent. Cheilocystidia (16-)21.6-28(-32) x 2.4-3.2 (-4) µm, hyaline, numerous but not conspicuous, subcylindric-moniliform, sometimes irregularly lobulated or subramified, clamped at the base. Hymenial trama subregular, hyphae 4-8 µm wide, thin walled and smooth. Pileus cuticle with radially arranged cylindric hyphae, (2.4-) 4-9.6 (-12) µm, hyaline, smooth or with brown and short granulations observed in KOH. Context hyphae 6.4-12 µm diam., hyaline, smooth. Stipe trama hyphae 6.4-12 µm diam., hyaline, smooth. Caulocystidia not observed.

TABLE 1. SPECIES OF *COLLYBIA* REPORTED FROM MEXICO

C. acervata (Fr.) Kumm. (Guzmán, 1961) *
C. alkalivirens Sing. (Guzmán, 1977)
C. butyracea (Bull. : Fr.) Kumm. (Guzmán, 1972)
C. confluens (Pers. : Fr.) Kumm. (Guzmán, 1977)
C. distorta (Fr.) Quél. (Martínez-Alfaro *et al.* 1983)
C. dryophila (Bull. : Fr.) Kumm. (Murrill, 1910)
C. fimetaria (Murr.) Murr. (Murrill, 1916)
  [actually ***Mycena fimetaria*** (Murr.) Sing.]
C. fibrosipes (B. & C.) Dennis (Guzmán, 1977)
C. fuscopurpurea (Pers. : Fr.) Kumm. (Halling, 1990)
C. fusipes (Bull. : Fr.) Quél. (Guzmán, 1961)
C. iocephala (B. & C.) Sing. (Welden *et al.*, 1979)
C. maculata (Alb. & Schw. : Fr.) Kumm. (Guzmán, 1977)
C. orizabensis (Murr.) Murr. (Murrill, 1916)
C. platyphylla (Pers. : Fr.) Kumm. (Sharp, 1948)
  [actually ***Tricholomopsis platyphylla*** (Pers. : Fr.) Sing.]
C. peronata (Bolt. : Fr.) Kumm. (Guzmán, 1977)
C. polyphylla (Peck) Sing. ex Halling (Guzmán, 1977)
C. roseilivida (Murr.) Murr. (Murrill, 1916)
C. subcyathiformis (Murr.) Pegler (Murrill, 1915)
C. velutipes (Curt. : Fr.) Kumm. (Murrill, 1916)
  [actually ***Flammulina velutipes*** (Curt. : Fr.) Sing.]
C. xuchilensis (Murr.) Murr. (Murrill, 1916)
  [actually ***Hydropus xuchilensis*** (Murr.) Sing.]

*** Only the first reference to each species from Mexico is annotated.**

Habitat and distribution. Solitary or subgregarious, in subtropical or coniferous forests. It has been recorded from the States of Durango, Hidalgo, Jalisco, Mexico, Michoacan, Morelos, Oaxaca, Puebla, Veracruz and Zacatecas.

Material studied. STATE OF PUEBLA, Mercado de Teziutlán, Guzmán 29265. E from Teziutlán, Cerro de Techachapa, Bandala 1790. STATE OF VERACRUZ, Cofre de Perote Region, Municipio de Xico, N of Ingenio El Rosario, Los Gallos, Bandala 71, 1911, 1934, 1947; Chacón 4332-A; Tapia 112, 139; Ochoa 97. W of Tembladeras, Atopa, Bandala 1519 (all in XAL).

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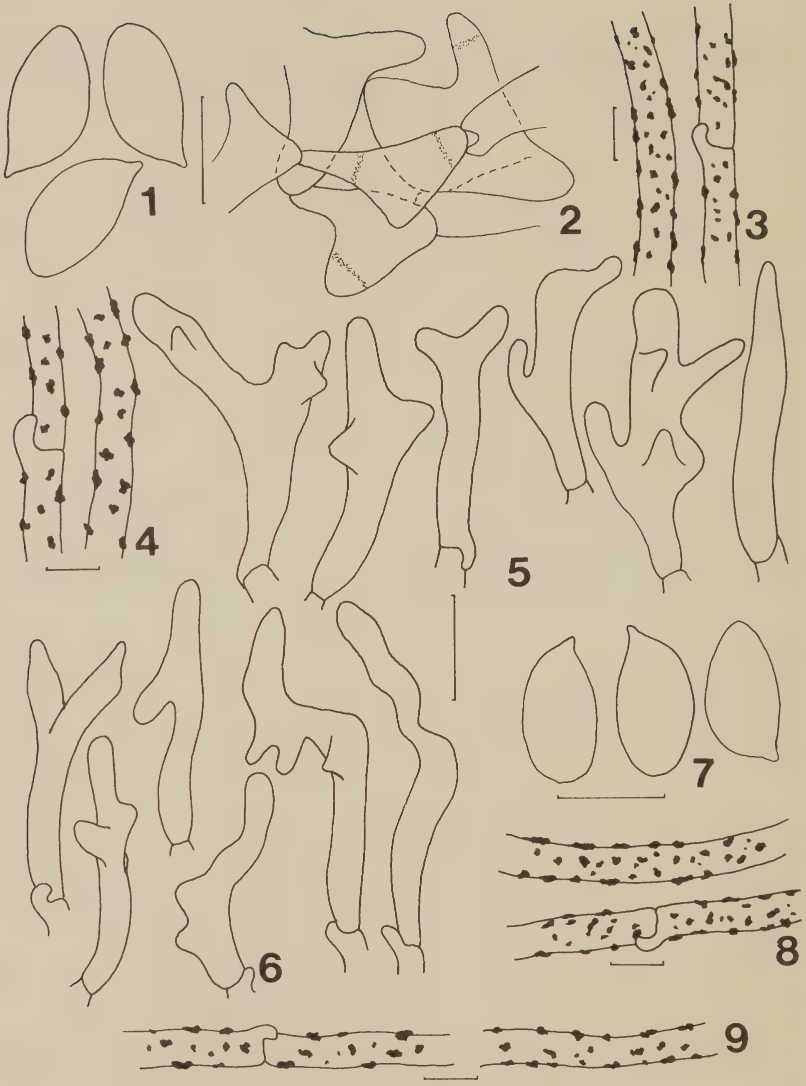
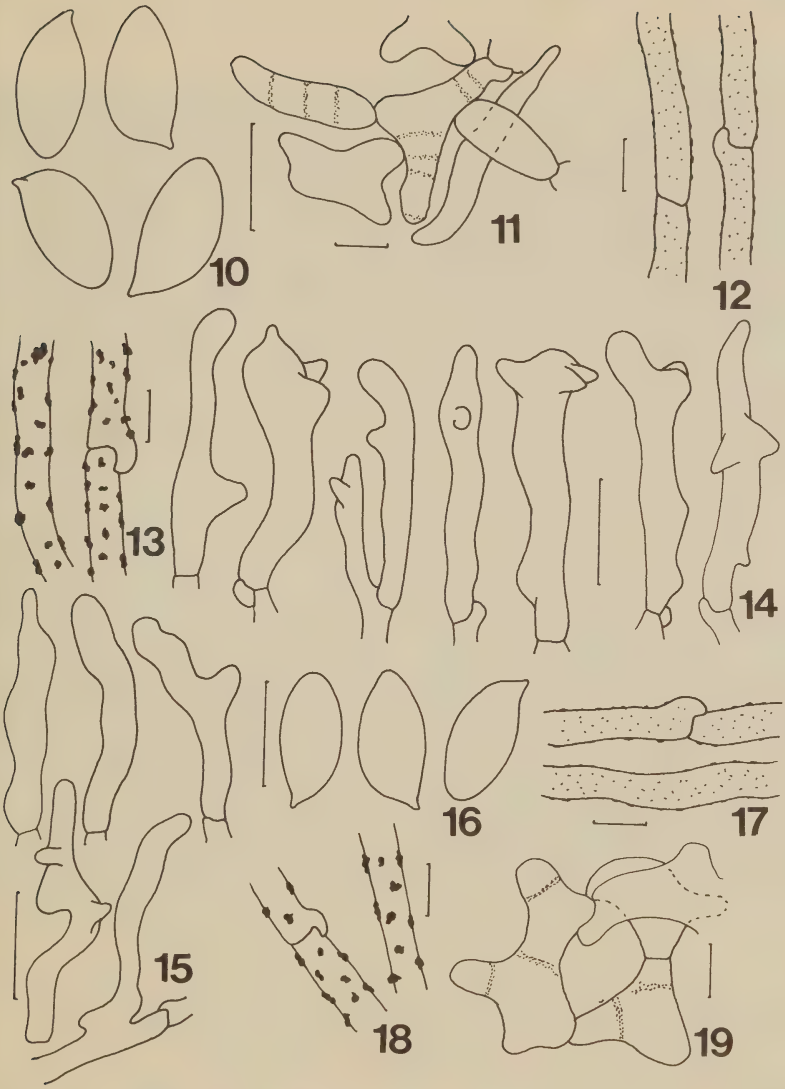
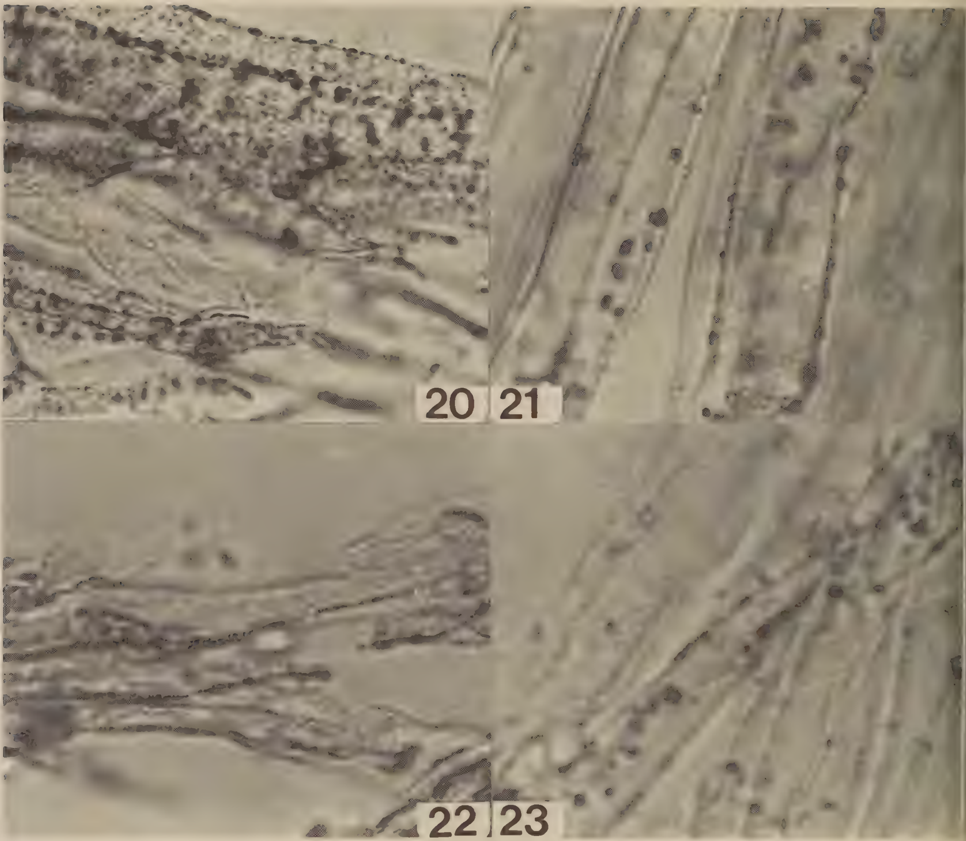


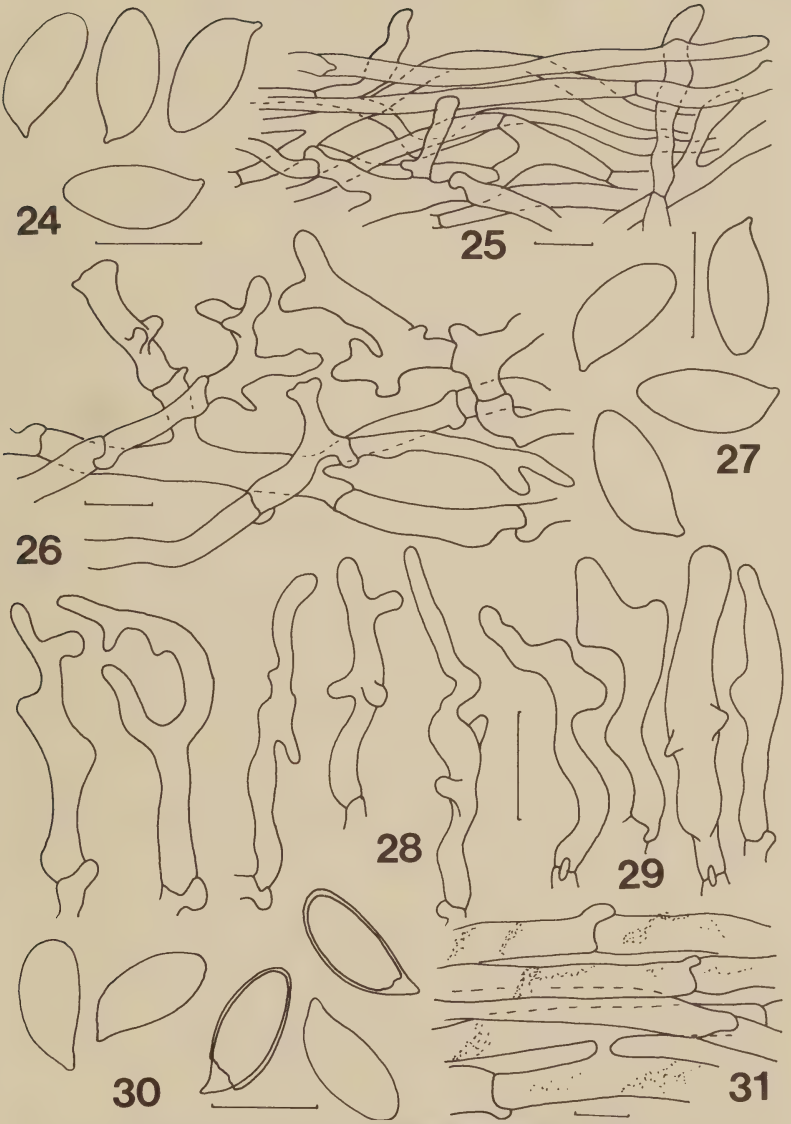
Figs. 1-9.- ***Collybia alkalivirens***, 1: spores; 2: pileus cuticle; 3: hymenial trama hyphae; 4: stipe trama hyphae; 5: cheilocystidia; 6: caulocystidia (Alvar González, s. n., Jun. 5, 1984); 7: spores; 8: hymenial trama hyphae; 9: stipe trama hyphae (Desjardin 464). (Scale bar, 1 & 7 = 5.3 µm; 2, 3-4, 6 & 8-9 = 16 µm & 5 = 20 µm).



Figs. 10-19.- ***Collybia fuscopurpurea***, 10: spores; 11: pileus cuticle; 12: hymenial trama hyphae; 13: stipe trama hyphae; 14: cheilocystidia; 15: caulocystidia (Villarreal 1866); 16: spores; 17: hymenial trama hyphae; 18: stipe trama hyphae; 19: pileus cuticle (Halling 4888). (Scale bar, 10-11, 16 & 19 = 10 μm; 12-13 & 17-18 = 16 μm; 14 = 15 μm & 15 = 23 μm).



Figs.- 20-23.- ***Collybia alkalivirens*** and ***C. fuscopurpurea***: 20-21: ***C. alkalivirens***, 20: hymenial trama hyphae; 21: stipe trama hyphae. 22-23: ***C. fuscopurpurea***, 22: hymenial trama hyphae; 23: stipe trama hyphae (all mounted in water; 400 x) (20-21; Alvar González, s. n., Jun. 5, 1984; 22-23: Villarreal 1866).



Figs. 24-31.- 24-25: ***Collybia iocephala***, 24: spores; 25: pileus cuticle (Montoya 549). 26-28: ***C. polyphylla***, 26: pileus cuticle (Montoya 1636); 27: spores; 28: cheilocystidia (Bandala 1859). 29-31: ***C. butyracea***, 29: cheilocystidia; 30: spores; 31: pileus cuticle (Chacón 4332-A). (Scale bar, 24, 27 & 30 = 4.8 μm; 25-26 = 10 μm; 28 = 16 μm; 29 = 9 μm & 31 = 11.8 μm).

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THE CHEMISTRY OF FOLIICOLOUS LICHENS. 1. CONSTITUENTS OF SPOROPODIUM VEZDEANUM AND S. XANTHOLEUCUM

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ABSTRACT : An investigation of the chemical constituents present in the lichens *Sporopodium vezdeanum* and *S. xantholeucum* has revealed that both species contain the depsidone pannarin and the triterpene zeorin together with a chemosyndrome of chloro-xanthones. This is one of the few reported chemical studies of foliicolous lichens and indicates that secondary metabolite chemistry may well provide important characters in the taxonomy of such genera. A new name *Sporopodium vezdeanum* Lumbsch and Elix has been proposed for *S. phyllocharis* var. *flavescens*. 5,7-Dichlorolichexanthone is reported for the first time from a lichen.

Introduction

Natural product chemistry has played an important role in lichen taxonomy ever since Nylander (1866) introduced chemical reagents as an aid for the identification of lichen species. Current concepts in lichen chemotaxonomy and the alternative views on the taxonomic value of chemical characters have been reviewed by Egan (1986) and Culberson (1986).

Although the large majority of lichen groups have been the subject of such chemical investigation (Culberson, 1969, 1970; Culberson & Elix, 1989; Culberson, Culberson & Johnson, 1977; Elix, Whitton & Sargent, 1984) there have been very few studies of foliicolous lichens (Santesson, 1970). Undoubtedy the lack of material accounts for this deficiency, but with more sensitive methods for detection and identification, in particular high performance liquid chromatography (HPLC) and lichen mass spectrometry (LMS) (Culberson & Elix, 1989) this should no longer be the case.

Following our recent investigation on some xanthone-containing chemosyndromes in the genera *Lecanora, Lecidella, Micarea* and *Pertusaria* (Elix, Chappell & Jiang 1991; Elix & Crook, 1992), we have turned our attention to several yellow members of the foliicolous genus *Sporopodium*. Two species were studied, *Sporopodium vezdeanum* Lumbsch & Elix nom. nov. [Basionym: *Sporopodium phyllocharis* (Mont.) Mass. var *flavescens* R. Sant., Symb. Bot. Upsal. 12:518 (1952)] and *Sporopodium xantholeucum* (Müll. Arg.) A. Zahlbr. The secondary metabolites present in these two species and their relationships are discussed.

Materials and Methods

The lichen fragments were freed as far as possible from obvious organic substrate material and extracted with warm acetone for thin layer chromatography (TLC) or with warm methanol for HPLC. Compounds were identified by TLC using the methods standardized for lichen products (Culberson & Ammann, 1979; Culberson & Johnson 1976, 1982; Elix, Johnston & Parker, 1987) and by high performance liquid chromatography (HPLC) (Elix, Jenkins and Lumbsch, 1988; Elix & Crook, 1992; Elix, Chappell & Jiang, 1991; Feige, Lumbsch & Mies, 1992; Lumbsch & Elix, 1985) with retention index values (RI) (Huovinen, Hiltunen & Schanz, 1985) calculated from salazinic acid and atranorin controls. Two HPLC systems were used. One used a Perkin-Elmer HS-5C18 column and a LC-85 spectrometric detector operating at 254 nm. Elution was effected with 90% water-methanol containing orthophosphoric acid (20ml/100ml) with a flow rate of 0.6 ml min^{-1}. The second HPLC system used a Kontron Li-Chrosorb RP-18 column. Two solvent systems were used; 1% orthophosphoric acid (A) and methanol (B). The run started with 30% B and was raised to 70% B within 15 min., then to 100% B in 30 min. and isocratic elution in 100% B for a further 20 min. Lichen mass spectra (LMS) (Santesson 1969) were recorded at a VG micromass 7070F mass spectrometer at 70eV linked online to Finnigan Incos data system.

The following lichens were studied.

***Sporopodium vezdeanum* Lumbsch & Elix**

AUSTRALIA, Queensland. On leaves, Sylvesters Lookout rainforest, Mistake Mts., Goomburra State Forest, ca. 50 km NE of Warwick, 27°58'S, 152°31'E, *H.T. Lumbsch 5685c & R.W. Rogers*, 26. ix. 1987 (herb. Lumbsch). New South Wales. On leaves in remnant rainforest Yatteyattar, Currowar Creek, 35°16'S, 150°25'E, *H. T. Lumbsch 8941 & T. S. Henshall*, 8. viii. 1991(ANUC).

NORFOLK ISLAND. On palm leaves in mixed subtropical rainforest, Mt. Pitt Reserve, Filmy Fern Trail, 29°01'S, 167°57'E, 130m, *J.A. Elix 18400 & H. Streimann, J.A. Elix 18410 & H. Steimann,* 3.xii. 1984 (ANUC).

***Sporopodium xantholeucum* (Müll. Arg) A. Zahlbr.**

AUSTRALIA. Queensland. On leaves in tropical rainforest, Sonita waterfalls, Atherton Tableland, *H.T. Lumbsch 5437/17E*, 16. viii. 1987 (herb. Lumbsch); on leaves of *Lomandra* sp. in subtropical rainforest, Mistake Mts. 28°19'S, 152°22'E, *H.T. Lumbsch 5701i & R.W. Rogers, H.T. Lumbsch 5705a & R.W. Rogers,* 29. ix. 1987 (herb. Lumbsch); on leaves, Sylvesters Lookout rainforest, Mistake Mts., Goomburra State Forest, *ca.* 50 km NE of Warwick, 27°58'S, 152°31' E, *H.T. Lumbsch 5687a & R.W. Rogers,* 26.ix. 1987 (herb. Lumbsch).

Authentic pannarin was isolated from *Pannaria elatior* Stirton while zeorin (Elix, Whitton & Jones, 1982) was available from previous work. Authentic 2,5-dichloronorlichexanthone and thiophanic acid were supplied by Dr S. Huneck (Huneck 1966, Huneck & Höfle, 1978). 2,7-Dichlorolichexanthone was prepared by the literature method (Sundholm, 1978). The following have been synthesised or isolated previously: 2,7-dichloronorlichexanthone and asemone (Elix, Jiang & Wardlaw, 1990); arthothelin and isoarthothelin (Elix, Jiang & Portelli, 1990); 5,7-dichloro-3-*O*-methylnorlichexanthone and 2,5,7-trichloro-3-*O*-methylnorlichexanthone (Elix & Jiang, 1990); 5,7-dichlorolichexanthone and 2,5,7-trichlorolichexanthone (Elix, Crook et al., 1992).

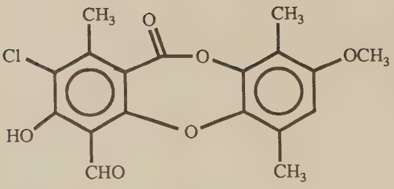
Results and Discussion

A total of 12 identifiable lichen substances were identified in the specimens examined. These included the β-orcinol depsidone, pannarin (1); the triterpene, zeorin (2); the chloro-xanthones, 2,7-dichlorolichexanthone (3), 5,7-dichlornorlichexanthone (4), 5,7-dichloro-3-*O*-methylnorlichexanthone (5), 5,7-dichlorolichexanthone (6), arthothelin (7), isoarthothelin (8), asemone (9), 2,5,7-trichloro-3-*O*-methylnorlichexanthone (10), 2,5,7-trichlorolichexanthone (11) and thiophanic acid (12). The known lichen compounds were readily identified by comparison with authentic materials, but this is the first reported natural occurrence of 5,7-dichlorolichexanthone (6) in lichens. The identity of 5,7-dichlorolichexanthone was confirmed by direct comparison with a synthetic sample of (6) (by TLC, HPLC, and LMS). 2,5,7-Trichloro-3-*O*-methylnorlichexanthone (10) was reported previously as occurring in *Sporopodium phyllocharis* v.*flavescens* (Santesson, 1970). The standardized chromatographic data for these compounds are listed in Table 1.

Table 1: **Standardized Chromatographic Data for *Sporopodium* Metabolites**

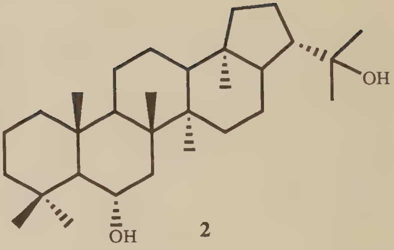
Standard R_F values (x 100) were determined in five independent t.l.c. solvent systems: (A) toluene / dioxane / acetic acid (180 : 45 : 5); ((B*) hexane / *t*-butyl methyl ether / formic acid (140 : 72 : 18); (C) toluene / acetic acid (170 : 30); (E) ethyl acetate / cyclohexane (25 : 75); (F) ethyl acetate / cyclohexane (50 : 50). HPLC retention index (RI) values (x 100) are relative to salazinic acid and atranorin.

Compound R_F	(A)	(B*)	(C)	(E)	(F)	*RI*
Pannarin (1)	73	63	79	40	64	96
Zeorin (2)	52	43	43	19	74	--
2,7-Dichlorolichexanthone (3)	77	70	80	24	57	163
5,7-Dichlornorlichexanthone (4)	44	48	33	11	43	60
5,7-Dichloro-3-*O*-methylnorlichexanthone (5)	67	67	59	16	40	140
5,7-Dichlorolichexanthone (6)	80	81	90	72	90	275
Arthothelin (7)	43	40	37	15	32	61
Isoarthothelin (8)	45	44	36	6	18	71
Asemone (9)	47	55	37	7	20	78
2,5,7-Trichloro-3-*O*-methylnorlichexanthone (10)	64	56	56	6	16	136
2,5,7-Trichlorolichexanthone (11)	87	74	85	58	90	235
Thiophanic acid (12)	55	52	49	2	9	122
Atranorin (Standard)	75	73	79	57	85	100
Chloroatranorin (Standard)	74	73	81	30	60	126
Norstictic Acid (Standard)	40	32	30	0	0	13

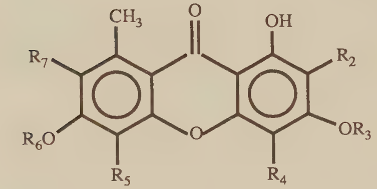


CH3
O
CH3
Cl
O
OCH3
HO
O
CHO
CH3

1



2

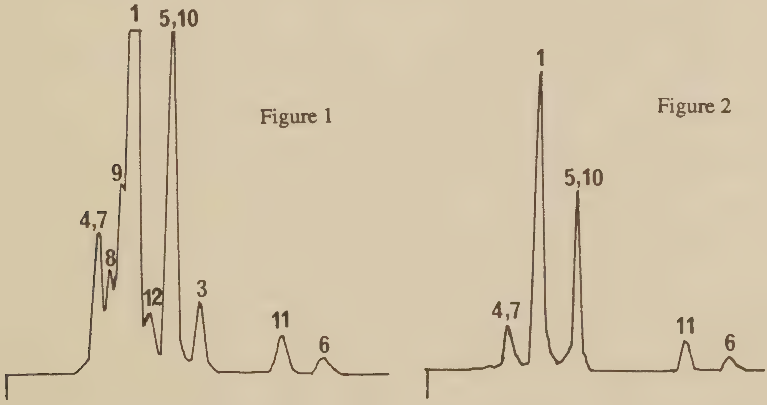


CH3
O
OH
R7
R2
R6O
O
OR3
R5
R4

	R_2	R_3	R_4	R_5	R_6	R_7
3,	Cl	Me	H	H	Me	Cl
4,	H	H	H	Cl	H	Cl
5,	H	Me	H	Cl	H	Cl
6,	H	Me	H	Cl	Me	Cl
7,	Cl	H	Cl	Cl	H	H
8,	Cl	H	H	Cl	H	Cl
9,	H	H	Cl	Cl	H	Cl
10,	Cl	Me	H	Cl	H	Cl
11,	Cl	Me	H	Cl	Me	Cl
12,	Cl	H	Cl	Cl	H	Cl

The two species studied, *Sporapodium vezdeanum* and *S. xantholeucum* showed remarkedly similar chemical profiles (compare Figures 1 and 2). The only apparent difference concerned the relative intensities of some of the minor xanthones e.g. 2,7-dichlorolichexanthone. An analogous chemosyndrome of related chloro-xanthones has been identified previously in the lichens *Lecanora broccha* Nyl. (Elix, Chappell & Jiang, 1991; Elix & Crook, 1992) and *Lecidella meiococca* (Nyl) Leuckert & Hertel (Elix & Crook, 1992), but not in combination with the depsidone pannarin. *S. xantholeucum* has previously been reported to contain the pulvinic acid derivatives pulvinic dilactone, vulpinic acid and calycin (Santesson, 1970) but these substances were not detected in the collections examined.

Morphological descriptions and a discussion of the distribution of both species of *Sporopodium* are given by Santesson (1952). The two species can be distinguished morphologically by the margins of the apothecia. The apothecia of *S. xantholeucum* have thick margins (at least when young), while in *S. vezdeanum* the margins are not prominent. Santesson treated *S. vezdeanum* as a variety of the pantropical species, *S. phyllocharis*. However *S. vezdeanum* differs in morphology (Santesson 1952) and distribution, being confined to Australia, Norfolk Island and New Caledonia. Hence we are convinced that this taxon should be regarded as a distinct species and have introduced the new name *vezdeanum* in honour of our friend Dr. Antonin Vĕzda, for his many contributions to the knowledge of foliicolous lichens.



Figures 1-2. H.p.l.c. traces of *Sporopodium* sp. : 1, *S. vezdeanum* (*H. T. Lumbsch 8941 & T. S. Henshall* in ANUC); 2, *S. xantholeucum* (*H.T. Lumbsch 5701i & R.W. Rogers* in herb. Lumbsch).

Index to H.p.l.c. Peaks: pannarin (1); 2,7-dichlorolichexanthone (3), 5,7-dichlornorlichexanthone (4), 5,7-dichloro-3-*O*-methylnorlichexanthone (5), 5,7-dichlorolichexanthone (6), arthothelin (7), isoarthothelin (8), asemone (9), 2,5,7-trichloro-3-*O*-methylnorlichexanthone (10); 2,5,7-trichlorolichexanthone (11); thiophanic acid (12).

ACKNOWLEDGEMENTS

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MYCOTAXON

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CORALLICOLA NANA GEN. & SP. NOV. AND OTHER ASCOMYCETES FROM CORAL REEFS

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ABSTRACT

Corallicola nana (Ascomycotina, Halosphaeriaceae) is described from a subtidal dead coral slab in Belize (Central America) and compared with a similar genus, *Arenariomyces* Höhnk. Evaluation of new and old collections of *Koralionastes* adds considerable information on the biogeography of the five coral-inhabiting species. *K. angustus* and *K. giganteus* appear to be restricted to Belize (Caribbean), where the first is a frequent representative, while *K. giganteus* is found only rarely. Both *K. ellipticus* and *K. ovalis* occur in Belize, Australia, and Fiji; *K. ellipticus*, moreover, in St. Croix (U.S. Virgin Islands). At this point, *K. violaceus* has been found only in the Pacific (Australia, Fiji).

INTRODUCTION

The regular occurrence of filamentous higher fungi on coral reefs has been discovered only recently (Kohlmeyer & Volkmann-Kohlmeyer 1987, 1988, 1989, 1990, 1992). In the course of searches for fungi on corals and coral rubble of the Caribbean and the Pacific, we found a new genus and species of ascomycetes that is described in the following. New records of *Koralionastes* spp. are also reported.

1. A new ascomycetous genus from corals

Corallicola Volkm.-Kohlm. & Kohlm., *gen. nov.*

Etymology: From the Latin *corallum* = coral and -*cola* = dweller, in reference to the substrate.

Genus Halosphaeriacearum. **Ascomata** subglobosa, superficialia, ostiolata, breve papillata vel epapillata, subiculata, coriacea, brunnea, singularia vel gregaria; **peridium** leptodermum, texturam angularem formans; **centrum** cellulis pseudoparenchymaticis, leptodermis, deliquescentibus; **asci** leptodermi, deliquescentes; **ascosporae** ellipsoideae, uniseptatae, hyalinae, appendiculatae; ad apices ambos aliquot appendiculis terminalibus, gibbosis ad basem, complanatis ad centrum, gradatim contractis ad apicem.
Typus generis: *Corallicola nana* Volkm.-Kohlm. & Kohlm.

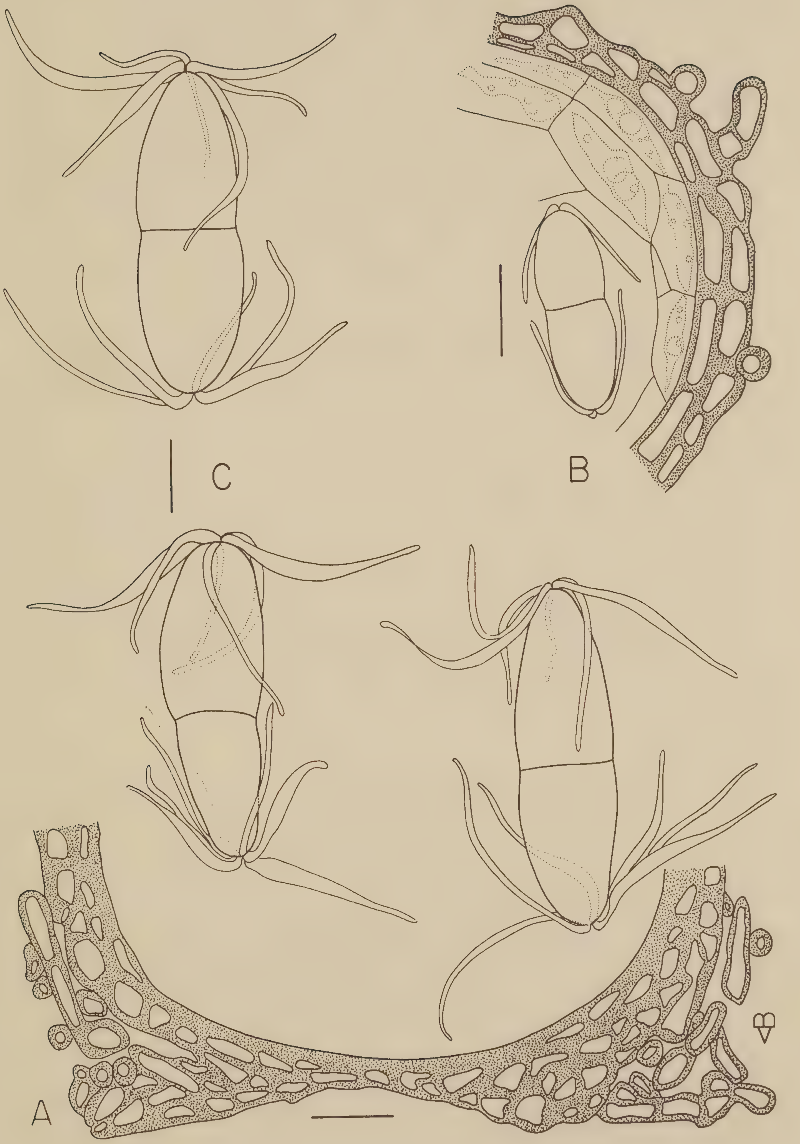
A genus of Halosphaeriaceae with one obligately marine species. **Ascomata** subglobose, superficial, ostiolate, short papillate or epapillate, subiculate, coriaceous, brown, single or gregarious. **Peridium** thin-walled, forming a *textura angularis.* **Centrum** of immature ascomata filled with pseudoparenchymatous, hyaline, deliquescent cells. **Asci** thin-walled, deliquescing. **Ascospores** ellipsoidal, one-septate, hyaline, appendiculate; at both apices with several terminal appendages, gibbous at the base, flattened in the middle and gradually tapering towards the tip.

Corallicola nana Volkm.-Kohlm. & Kohlm, *sp. nov.*

Etymology: From the Latin *nanus* = dwarf, in reference to the small ascomata.

Ascomata 80-95 μm diametro, subglobosa, superficialia, ostiolata, breve papillata vel epapillata, subiculata, coriacea, atro-brunnea, interdum hyphis brevibus brunneis tectis, singularia vel gregaria; **peridium** 5-7 μm crassum, 1-2 stratis cellularum multangularium, texturam angularem formantia; **paraphyses** absentes, centra ascomatum immaturorum cellulis pseudoparenchymaticis, hyalinis, leptodermis, deliquescentibus; **asci** leptodermi, deliquescentes ante maturitatem ascosporarum; **ascosporae** 21.0-26.5 x 7.0-8.5 μm ($\bar{x}$ = 23.5 x 7.7 μm; n = 37), ellipsoideae, uniseptatae, ad septum leniter constrictae, hyalinae, appendiculatae; ad apices ambos 5-7 appendiculis terminalibus, 15-18 μm longis, 1.4-1.7 μm latis ad centrum, 0.5 μm diam ad apicem.
SUBSTRATUM: Saxa corallinarum mortuarum
DISTRIBUTIO: Oceanus Atlanticus (Belize)
HOLOTYPUS: J. K. 5004 (IMS)

Fig. 1. *Corallicola nana.* (A) Section through peridium with basal subiculum (scale = 10 μm). (B) Section through lateral part of peridium with thin-walled pseudoparenchyma (scale = 10 μm). (C) Ascospores (scale = 5 μm).


C
B
A
B

Ascomata 80-95 μm in diam., subglobose, superficial, ostiolate, short papillate or epapillate, subiculate, coriaceous, dark brown, sometimes covered by short brown hyphae, solitary or gregarious. **Peridium** 5-7 μm thick, composed of one or two layers of polygonal cells, forming a *textura angularis*, dark brown (Fig. 1B); at the base attached to the substrate with a thin subiculum that is more or less hyphoid (*textura intricata*) or dense (*textura angularis*) (Fig. 1A). **Pseudoparenchyma** of thin-walled polygonal cells filling the centrum of young ascomata, deliquescing at ascospore maturity; no indication of pit-connections in the walls (Fig. 1B). **Asci** thin-walled, deliquescing before ascospore maturation. **Ascospores** 21.0-26.5 x 7.0-8.5 μm ($\bar{x}$ = 23.5 x 7.7 μm; n = 37), ellipsoidal, 1-septate, slightly constricted at the septum, hyaline, appendaged (Fig. 1C); at each end with 5-7 terminal appendages, 15-18 μm long, round and swollen at the base, 1.4-1.7 μm wide and flat in the middle, and tapering to the thin (0.5) μm round tip.

SUBSTRATE: Lower side of lose dead coral slab.

RANGE: Caribbean (known only from Belize, Central America).

Material examined: Subtidal coral slab, back reef of South Water Cay, Belize, 16°49'N, 88°04'45"W, 24 Nov. 1986, J.K. 5004 (HOLOTYPE, IMS).

Corallicola nana appears to be a rare fungus, because we found only one colony among hundreds of dead coral slabs that we examined in the Caribbean and the Pacific Ocean while looking for *Koralionastes*. Ascomata were attached to the lower side of the coral slab in a rusty-brown area, some of them partly covered by a thin, white crustaceous sponge. *Corallicola nana* is possibly associated with sponges, like species of *Koralionastes* which live in the same kind of habitat (Kohlmeyer & Volkmann-Kohlmeyer 1987, 1990). It must be clarified in this context that the corals are dead, broken off pieces of rubble of variable size; the fungus is not responsible for the damage or death of the coral.

At first sight, *C. nana* appears quite similar to members of the genus *Arenariomyces* Höhnk. Examination of ascomata and ascospores under oil immersion clearly show crucial differences between the new fungus and the type species of *Arenariomyces*, viz. *A. trifurcatus* Höhnk. In *C. nana* the pseudoparenchyma of the centrum has no pit-like connections where the contracted cytoplasm of adjoining cells touches the walls (Fig. 1B) as is the case in *A. trifurcatus* (Kohlmeyer & Kohlmeyer 1968, Pl. 73, Fig. 2). Furthermore, the 5-7 terminal appendages at each ascospore end of *C. nana* are swollen at the base, flat and wide in the middle and tapering to a thin round tip (Fig. 1C); whereas *A. trifurcatus* has 3 subterminal appendages with bulbous bases at each end. The appendages are round in cross section, taper towards the tip and terminate in an apical thickening or bifurcated structure (Jones et al. 1983). Appendages in *A. trifurcatus* grow directly from the spore wall (Jones et al. 1986). The ontogeny of appendages in *C. nana* is conceivably similar, but can be determined with certainty only by electronmicroscopic studies. Finally, there is a major ecological difference between *C. nana* and *A. trifurcatus*. The former grows subtidally offshore on dead coral rocks, whereas *A. trifurcatus* is a member of the intertidal arenicolous beach mycota (Kohlmeyer & Kohlmeyer 1979; Kirk 1983).

2. New records of *Koralionastes* spp.

The initial biogeographic records of five species of *Koralionastes* presented in Kohlmeyer & Volkmann-Kohlmeyer (1987, 1990) are supplemented with numerous additional data based on the evaluation of old and new collections. The collecting sites in the list have the following symbols:

AUSTRALIA

H = Heron Island, Queensland, 23°27′S, 151°55′E
O = One Tree Island, Queensland, 23°30′S, 152°03′E

FIJI

S = Suva, Viti Levu, 18°11′S, 178°27′E
K = near Korolevu, Viti Levu, 18°15′S, 177°42′E

BELIZE, CENTRAL AMERICA

CB = Carrie Bow Cay, 16°48′N, 88°05′W
GNE = Glovers Reef, NE Cay, 16°45′N, 87°45′30"W
GS = Glovers Reef, SW Cay, 16°42′N, 87°49′30"W
SW = South Water Cay, 16°49′N, 88°04′45"W
TO = Tobacco Cay, 16°54′30"N, 88°03′30"W

ST. CROIX, U.S. VIRGIN ISLANDS

CR = Grass Point, 17°44′06"N, 64°36′40"W

Koralionastes angustus Kohlm. & Volkm.-Kohlm.

BELIZE - **CB**: 21 May 1987, J.K. 5024; 15 Oct. 1988, J.K. 5191; **GNE**: 24 Oct. 1988, J.K. 5196, 5204; **SW**: 22 May 1987, J.K. 5025, 23 Oct. 1988, J.K. 5195; 25, 26 May 1989, J.K. 5265, 5267; **TO**: 24, 25, 29 May 1987, J.K. 5013, 5014, 5016, 5020; 2 June 1987, J.K. 5037; 28, 30 May 1989, J.K. 5271, 5273; 3 June 1989, J.K. 5278; 13, 16, 19 March 1990, J.K. 5365, 5366, 5367.

This species had been reported only once before from Carrie Bow Cay, Belize (Kohlmeyer & Volkmann-Kohlmeyer 1987). The 19 collections made on three additional islands in Belize show that *K. angustus* is relatively frequent and has been found in this area in March, May, June, October, and November.

Koralionastes ellipticus Kohlm. & Volkm.-Kohlm.

AUSTRALIA - **H**: 24, 29 Feb., 1 Mar. 1988, J.K. 5127, 5183, 5221, 5222; **O**: 13 Oct. 1989, J.K. 5347. FIJI - **K**: 5 Oct. 1990, J.K. 5424. BELIZE - **CB**: 15, 18, 23 Oct. 1988, 5 June 1989, 18 Mar. 1990, J.K. 5197, 5198, 5199, 5282, 5283, 5359; **GNE**: 24 Oct. 1988, J.K. 5187, 5200, 5201, 5202; **GS**: 31 May 1987, 24 Oct. 1988, J.K. 5012, 5189, 5203; **SW**: 29 May 1989, J.K. 5272; **TO**: 24, 29 May 1987, 30 May, 3 June 1989, 13, 16, 19 Mar. 1990, J.K. 5018, 5019, 5275, 5276, 5279, 5357, 5358, 5360. ST. CROIX - **CR**: 24, 25 Sept., 6 Oct. 1987, J.K. 5045-5048.

Until now, *K. ellipticus* was known only from one island in Belize (South Water Cay; Kohlmeyer & Volkmann-Kohlmeyer 1987). In the Caribbean we collected it on four additional Belizean islands; it is new for the U.S. Virgin Islands, and for the Pacific where we found it on two Australian islands in the Great Barrier Reef and in Fiji. Collections of mature ascomata were made in the Caribbean from March until November (no trips were made in July and August), in the Pacific in February, March and October.

Koralionastes giganteus Kohlm. & Volkm.-Kohlm.

BELIZE - **CB**: 18 Mar. 1990, J.K. 5363; **SW**: 11, 14, 20 Mar. 1990, J.K. 5354, 5355, 5364.

Records of *K. giganteus* existed for two Belizean islands, Southwater and Tobacco Cays (Kohlmeyer & Volkmann-Kohlmeyer 1990); a third, on Carrie Bow Cay, is added herewith. It appears to be much rarer than the other species of *Koralionastes* and mature ascomata were found so far only in March and May.

Koralionastes ovalis Kohlm. & Volkm.-Kohlm.

AUSTRALIA - **H**: 26, 28 Feb. 1988, J.K. 5225, 5228. FIJI - **K**: 5 Oct. 1990, J.K. 5423. BELIZE - **CB**: 23 May 1987, 15, 18 Oct. 1988, 5 June 1989, 18 Mar. 1990, J.K. 5015, 5017, 5029, 5030, 5031, 5205, 5208, 5281, 5368; **GNE**: 24 Oct. 1988, J.K. 5214, 5215, 5216; **GS**: 24 Oct. 1988, J.K. 5217, 5218, 5219; **SW**: 22 May 1987, 16, 17, 22, 23 Oct. 1988, 25, 27 May 1989, 17 Mar. 1990, J.K. 5025, 5182, 5206, 5207, 5210, 5211, 5212, 5213, 5266, 5268, 5362; **TO**: 24, 25 May, 2 June 1987, 21 Oct. 1988, 28, 30 May, 3 June 1989, 13, 16, 19 Mar. 1990, J.K. 5032, 5033, 5037, 5209, 5269, 5274, 5277, 5280, 5356, 5361, 5369.

This species was known before only from two collections in Belize on Curlew Bank and South Water Cay (Kohlmeyer & Volkmann-Kohlmeyer 1987). The numerous collections of *K. ovalis* made on four additional islands in Belize, as well as in Australia and Fiji indicate that it is nearly as common and widely distributed as *K. ellipticus*. We found mature ascomata in the Caribbean from March to June and October and November, in Australia in February and in Fiji in October.

Koralionastes violaceus Kohlm. & Volkm.-Kohlm.

FIJI - S: 3, 6 Oct. 1990, J.K. 5422, 5425.

So far, *K. violaceus* is known only from the Pacific Ocean, the Australian Great Barrier Reef and Fiji. Ascospores from Fiji are mostly 5-septate and 86-127 x 27-40 μm ($\bar{x}$ = 103 x 34 μm; n = 60), compared to the slightly thinner, mostly 4- to 5-septate spores from Australia that are 85-130 x 25-34 μm ($\bar{x}$ = 107 x 30 μm; n = 105; Kohlmeyer & Volkmann-Kohlmeyer 1990).

ACKNOWLEDGMENTS

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A NEW PHOMOPSIS WITH LONG PARAPHYSES

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ABSTRACT

A new species, *Phomopsis longiparaphysata*, is described from grapes in Taiwan. This fungus is distinctive because of its long, narrow, branched paraphyses and is the second *Phomopsis* described with paraphyses. It has also been isolated from fruits of *Spondias* sp. from Jamaica and from *Anacardium occidentale* from Kenya. Illustrations of all three isolates of *P. longiparaphysata* are provided along with illustrations of type material of *P. anacardii*.

KEY WORDS: *Phomopsis longiparaphysata* sp. nov., *Phomopsis javanica, Phomopsis anacardii, Spondias* sp., *Anacardium occidentale, Vitis sp. Cv. Black queen*

During a study of *Phomopsis* on asparagus *P. javanica* Uecker & Johnson (1991) was described as new because it exhibited sterile hypha-like structures extending from conidiophores or arising between conidiophores. Sutton (1980) used the term paraphyses for similar sterile hyphae in his descriptions of other genera of phialidic coelomycetes in which the sterile hyphae are found. Such structures had not previously been noted in *Phomopsis* despite the existence of more than 800 different epithets already published in this genus (Uecker, 1988). The earliest indication of paraphyses is found in an illustration of *Phomopsis theae* Petch (Punithalingam and Gibson, 1972), which showed a single paraphysis-like component. No reference to it occurred either in the text or in the legend to the figure. Another species, *P. anacardii* Early & Punithalingam (1972), was described with simple or branched conidiophores that sometimes were up to 75µm long, apparently referring to the components that we call paraphyses. However, Punithalingam (in litt., 1990) and co-workers believed that conidiomata of some species only occasionally have such structures, which they further believed are derived from sterile or underdeveloped conidiophores.

Two recently acquired isolates along with a specimen from IMI were found to possess long, narrow, branched paraphyses. This paper describes and illustrates a new species, *Phomopsis longiparaphysata,* that is morphologically distinct because of its unique paraphyses.

MATERIAL AND METHODS

The first isolate of *Phomopsis longiparaphysata* that came to our attention was designated ELP by K.-C. Kuo. The fungus originally came from fruit of grape (*Vitis sp. Cv. Black Queen*) collected in Taiwan in May, 1989. The original specimens have been lost but cultures have been maintained continuously on autoclaved pieces of stems of grape, asparagus (*Asparagus officinalis* L.), and alfalfa (*Medicago sativa* L.) on water agar (WA) as FAU-488. Methods for fixation, imbedding in paraffin, staining, rehydration of herbarium specimens, and study of conidia and conidiogenous apparatus have been detailed previously (Uecker and Johnson, 1991). To determine whether the conidiogenous apparatus and paraphyses varied morphologically at any stage of development from those at other stages and from those on the other host substrates, *P. longiparaphysata* was grown on stem pieces of alfalfa, asparagus, and grape on WA plates for 40 days. The conidiogenous apparatus and paraphyses were observed and photographed on days 5,6,7,8,12,13,15,18,22,26,28,32, and 34 after plating.

RESULTS

Phomopsis longiparaphysata Uecker et Kuo, sp. nov.

Mycelium hyalinum, immersum, ramosum, septatum; conidiomata brunnea vel atris, simpliciter eustromatica, immersa, plerumque dissita raro confluentia, ampulliformia vel complanata, loculo solitari interdum convoluto, 175-430(-550)µm longo x 157-275µm lato, paries fuscus apicem versus, ad latera

et infimum juventute pallidior, textura angularis; ostiolum papillatum, plerumque solitarium, circulare, 15-20µm diam; conidiophora hyalina, brevia vel elongata, plus minusve decrescentia, et basi et super septata, praeter terminalem ramo laterale longo vel breve infra septum omnes cellulae conidiophori conidiogenentes, 10-40 x 2-4µm; cellulae conidiogenae enteroblasticae, phialidicae, integratae vel discretae, hyalinae, apertura in ramo laterali apicali, canale et collulo minutis, spissitudine periclinali crassa vel non, 10-20 x 2-4µm; conidia acropleurogena; conidia alpha hyalina, aseptata plerumque biguttulata, elliptica vel fusiformia-elliptica, (5-)6-7(-11) x 2-2.5(-3.5)µm; conidia beta non visa; paraphyses hyalinae, septatae, ramosae, e cellula terminale conidiophori vel e cellulas iisdem atque conidiophoris, usque 130 x 1-2µm, in conidiomatibus plerumque abundantes.

Mycelium hyaline, immersed, branched, septate; conidiomata (Fig. 1) eustromatic, immersed, usually separate but sometimes confluent, brown to black, nearly globose to elliptic, ampulliform or flattened, 175-430 (-550) x 157-275µm wide, unilocular (Fig. 2), walls of the locule often convoluted, wall of textura angularis; usually one ostiole but sometimes more, usually papillate, circular, 15-20µm diam; conidiophores (Figs. 3,4) 10-40 x 2-4µm, hyaline, short or elongate, more less tapered toward the apex, septate both at base and above, each cell of the conidiophore except the terminal one producing a short or long lateral branch just below the septum and becoming conidiogenous; conidiogenous cells (Figs. 3,4) 10-20 x 2-4µm, enteroblastic, phialidic, integrated or discrete, hyaline, aperture apical on the lateral branch, channel and collarette minute, periclinal thickenings of variable thickness; conidia acropleurogenous; alpha conidia (Fig. 5) hyaline, aseptate, usually biguttulate but sometimes with one large or several small guttules, elliptic or fusiform-elliptic, (5-)6-7(-11) x 2-2.5(-3.5)µm; beta conidia not seen; paraphyses (Fig. 3,4) hyaline, septate, arising from the terminal cell of the conidiophore or from the same cells that give rise to conidiophores, usually branched, free at tips, to 130 x 1-2µm, generally abundant.

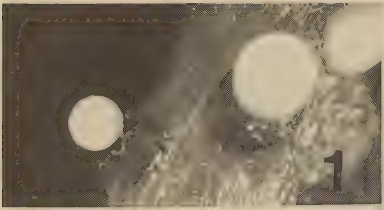
HOLOTYPE: US 1108873, on sterilized stems of alfalfa (*Medicago sativa* L.) in BPI. Isotypes in NY, DAOM, and IMI (abbreviations from Holmgren et al., 1990). Isolated from fruits of *Vitis sp. Cv. Black Queen* at Er-lin, Chang-Hwa Hsien, Taiwan.

The series of photographs taken 5-34 days after inoculation on stems of alfalfa, asparagus and grape on WA showed that five days after inoculation paraphyses were present on asparagus and alfalfa but not on grape. On the sixth day longer, branched paraphyses were present on all three hosts and by day seven some paraphyses were up to 90um long. Long, thin, branched paraphyses were present at all sampling times through 34 days. They were more numerous on day eight and thereafter than on days five to seven. The longest paraphyses, up to 130µm, were observed on and after day 18.

Two other isolates are considered to belong to this species. The first of these, designated as FAU-500, was isolated from fruit of *Spondias* sp. from Jamaica. Fruits were intercepted by inspectors from U.S. Animal and Plant Health Inspection Service at J.F. Kennedy International Airport on XI/16/1989, seq. no. 100 for that date. Conidiomata (Fig. 6) fall within the same size range as those of the type. The wall of the conidioma (Fig. 7) is typical textura angularis. Dimensions of the paraphyses and of the conidiophores (Fig. 8) are likewise similar. The isolate from *Spondias* has longer alpha conidia (6.5-)8-9(-10) than does the type (5-)6-7(-11)µm. Otherwise there is little to distinguish it from the type. Beta conidia have not been found either in the isolate from *Spondias* or in the type.

The second isolate that we consider conspecific with *Phomopsis longiparaphysata* is IMI 136470, labeled *Phomopsis* sp. on *Anacardium occidentale* L., coll. R. Prasad, det. M.P. Early, from Min. of Agriculture, Nairobi, Kenya, August, 1968. Conidiomata (Figs. 10,11) were black, ostiolate, papillate, (238-)370-520

Figs. 1-9. *Phomopsis longiparaphysata*. 1-5 from type culture on alfalfa stem on WA. 1. Habit, X46. 2. Section through conidioma, X193. 3. Portion of conidiogenous layer showing septate conidiophore with conidiogenous branch emerging from below septum and branched paraphyses arising from same cell as the conidiophore, X1000. 4. Portion of conidiogenous layer showing conidiophores and long, branched paraphyses, X1000. 5. Alpha conidia, X1000. 6-9 from isolate FAU-500 on *Spondias* from Jamaica grown on alfalfa stem on WA. 6. Habit, X50. 7. Section through conidioma, X280. 8. Portion of conidiogenous layer showing conidiophores and long, branched paraphyses, X1000. 9. Alpha conidia, X1000.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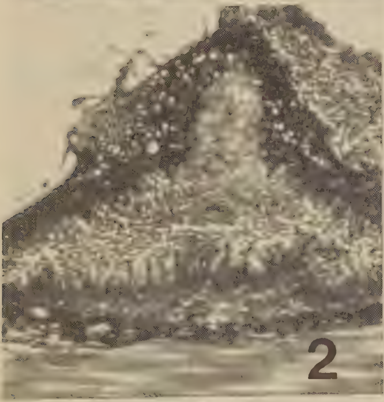
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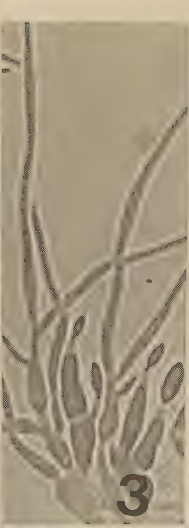
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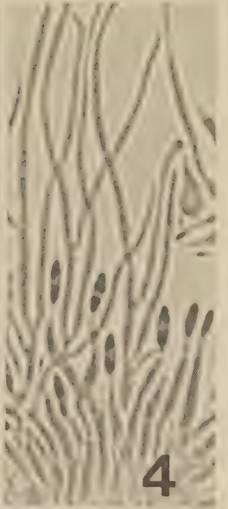
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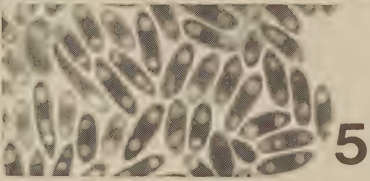
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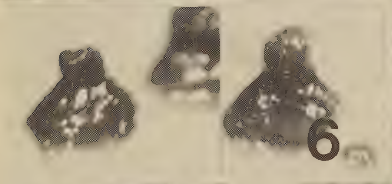
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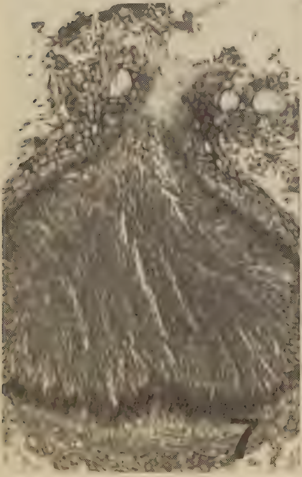
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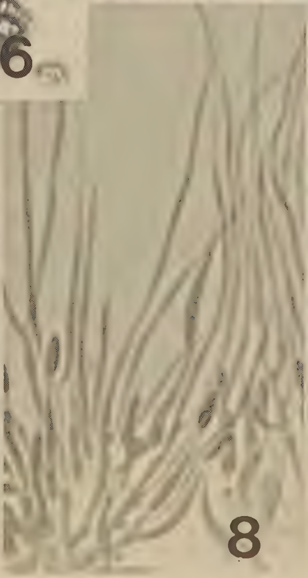
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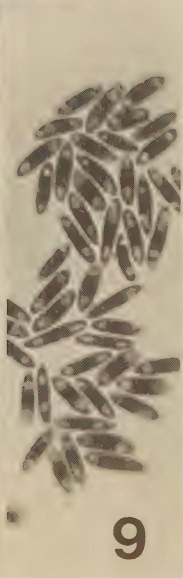
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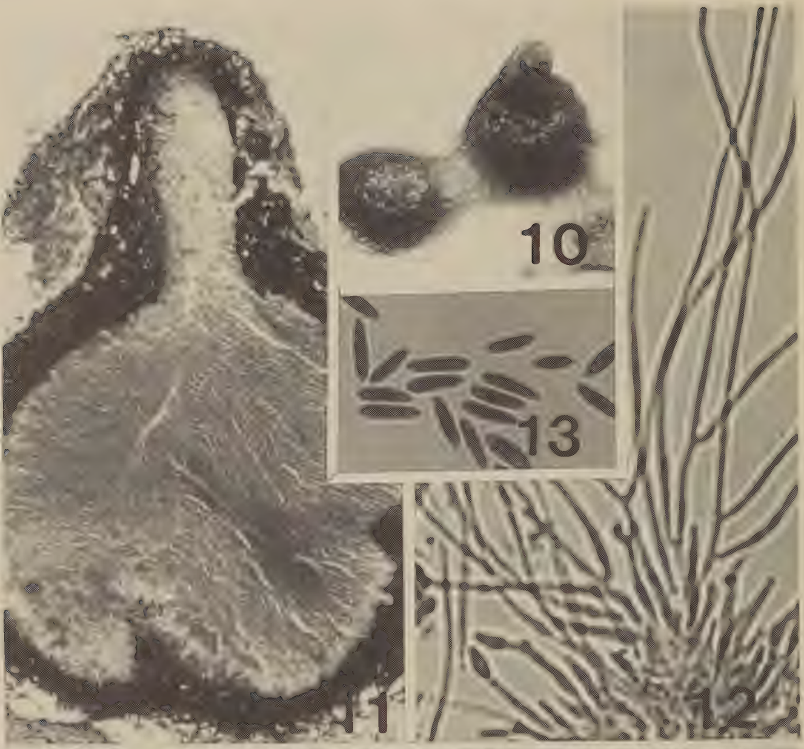
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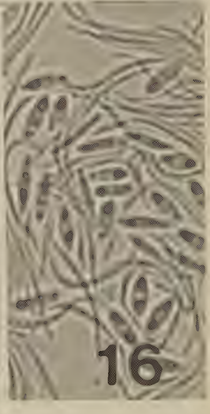
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x (213-)390-620µm high. Conidiophores (Fig. 12) were 10-30 x 1.5-2µm, more or less tapered near the apex. Conidiogenous cells (Fig. 12) were 10-20 x 1.5-2µm. Alpha conidia (Fig. 13) were (6-)7-9 x 2-2.5µm. Beta conidia were not seen. Of 16 specimens sent in response to a loan request for specimens of *Phomopsis anacardii*, this was the only one that showed long, narrow, branched paraphyses. This isolate is considered distinct from *P. anacardii* (Type: IMI 144866), which was described from leaves of *Anacardium occidentale* from Coast Province of Kenya. Punithalingam (1985) further reported *P. anacardii* from Africa (Gambia, Guinea, Mozambique, Nigeria, and Zambia); Asia (Bangladesh, Burma, India, Malaysia); Central America; and West Indies (Cuba, Jamaica). Conidiomata of *P. anacardii* were described as up to 600µm wide, black or blackish brown, numerous, stromatic, solitary or aggregated, unilocular or multilocular, ostiolate. Conidiophores were hyaline, simple or branched, septate or non-septate, cylindric to obclavate, straight, 10-18 x 3-5µm, sometimes up to 75µm long. Such long conidiophores were not illustrated either in the original illustrations or in the photographs provided by Punithalingam (1985). The portion of the type specimen that we examined had neither long conidiophores up to 75µm in length nor any other elements extending above the usual height of the conidiogenous cells. Young conidiogenous cells (Fig. 14) were up to 24µm long and 3µm wide with rounded apices. Beta conidia later developed from such conidiogenous cells (Fig. 15). The few conidiomata present on this specimen contained many beta conidia but considerably fewer alpha conidia. Conidiogenous cells with alpha conidia still attached were not seen. Alpha conidia were described as 6-8(-10) x 2-2.5(-3)µm. The ones we saw (Fig. 16) were 5-6(-9) x 2-2.5µm, with 87% in the 5-6µm range. Beta conidia were 20-26 x 1µm.

Figs. 10-16. 10-13 *Phomopsis longiparaphysata*, IMI 136470 on dried agar. 10. Habit, X50. 11. Section through conidioma, X137. 12. Portion of conidiogenous layer showing conidiophores and long branched paraphyses, X1000. 13. Alpha conidia, X1000. 14-16 *P. anacardii*, IMI 144866 ex type. 14. Young conidiogenous cells, X1000. 15. Portion of conidiogenous layer producing mostly beta conidia, X1000. 16. Alpha and beta conidia, X1000.

DISCUSSION

Little work has been done with coelomycetes that possess paraphyses. Sutton and Sellar (1966) pointed out that there are few references in the literature to such sterile hyphae in Sphaeropsidales and Melanconiales. Several terms have been used for them. Clements and Shear (1931) used the term pseudoparaphyses for such structures in *Lichenophoma* Keissler, *Pleosphaeropsis* Died., *Cytoplea* Bizz. & Sacc., *Camarographium* Bubak, *Lagynodella* Petrak, *Gloeodes* Colby, and *Michenera* Berk. & Curtis. Bender (1934) used the term paraphyses in *Pleosphaeropsis, Camarographium*, *Lagynodella*, *Gloeodes*, *Plectophomella* Moesz, *Sphaeronaemopsis* Speg., *Naemosphaera* (Sacc.) Karst. and *Macrophomopsis* Petrak. Petrak and Sydow (1927) referred to pseudoparaphysoids in *Coleophoma* Hoehnel. Sutton (1980) employed the term paraphyses to refer to sterile hyphae in *Amerosporium* Speg., *Aschersonia* Mont., *Coleophoma, Massariothea* Sydow, *Phaeocytostroma* Petrak, *Plectophomella, Pseudorobillarda* Morelet, and *Titaeospora* Bubak. Further studies are needed to determine if all these structures are homologous. We found no mention of any of them becoming conidiogenous, although Sutton (1980) in the description of *Titaeospora* mentioned that paraphyses formed from the acervular tissue and from conidiogenous cells.

It seems problematical that paraphyses sometimes become conidiogenous and that they arise from the innermost layer of cells that also gives rise to conidiophores. Whether paraphysis is the appropriate term to apply to these structures is uncertain. If they usually become conidiogenous, then "immature conidiophores" might be appropriate. The term "paraphysis" implies that they are sterile structures with questionable function. It seems reasonable to use the latter term as long as the structure is sterile and call it a conidiophore when conidium formation begins.

This is the second species of *Phomopsis* that is considered distinctive because of its paraphyses. The first, *P. javanica,* has much shorter, broader, mostly unbranched paraphyses, has distinctly larger alpha conidia, and produces beta conidia. No teleomorph is known for either.

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PODOSORDARIA INGII SP. NOV. AND ITS LINDQUISTIA ANAMORPH

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ABSTRACT

Podosordaria ingii sp. nov. is described and illustrated from a frond of *Phoenix dactylifera* collected in the Canary Islands. Its *Lindquistia* anamorph is described on features of synnemata produced in nature and in culture.

A collection of a new species of *Podosordaria* Ellis & Holw. was kindly made available to us by the collector, Bruce Ing, Chester College, Chester, UK. We have named this fungus in honor of the collector. Fortuitously, the anamorph was present in close association with the teleomorph. The anamorph was likewise produced in cultures initiated from ascospores, allowing the anamorph-teleomorph connection to be made unequivocally.

Podosordaria ingii J. D. Rogers & Laessøe, sp. nov. Figs. 1-16.

Capitula stromatum rotunda, irregulariter compressa, usque ad 1 cm lata x 4 mm crassa, stipitibus usque ad 2 cm longitudine x 2 mm diam, extus fulva cum ostiolis atris, intus alba. Textura satis dura, strato carbonaceo destituto. Superficies asperata a ambitibus peritheciorum et rugis. Perithecia 0.3-0.5 mm diametro. Ostiola papillata. Asci octospori, cylindrici, stipitati, 110-130 µm longitudine tota x 7-9 µm crassi, partibus sporiferis 65-72 µm longitudine, annulo apicali in liquore iodato Melzeri cyanescente, cuneato, 1.5 µm alto x 2.9 µm crasso. Paraphyses simplices, copiosae. Ascosporae brunneae, unicellulares, ellipsoideo-inaequilaterales, leves, (8-) 9-10.5 x 4.5-5 (-6) µm, rima germinativa recta ventrali longa praeditae.

Status agamicus ad *Lindquistiam* pertinet. Synnemata consociata cum statu sexuali. Pars fertilis clavata, nivea, usque ad 1 mm diam, in stipite atros ca. 0.5 mm diam, usque ad 3 mm longitudine tota. Conidia et apparatus conidicus ut in genere.

Stromatal heads rotund, irregularly compressed, up to 1 cm broad x 4 mm thick, with stipes up to 2 cm long x 2 mm diam (Fig. 1), externally tawny with black ostioles, internally white. Texture fairly hard, lacking carbonaceous layer. Surface roughened by perithecial contours and wrinkles (Fig. 8). *Perithecia* 0.3-0.5 mm diam. Ostioles papillate. *Asci* eight-spored, cylindrical, stipitate, 110-130 μm total length x 7-9 μm broad, with the spore-bearing part 65-72 μm long, with apical ring bluing in Melzer's iodine reagent, cuneate, 1.5 μm high x 2.9 μm broad (Fig. 5). Paraphyses simple, abundant. *Ascospores* brown, unicellular, ellipsoid-inequilateral, smooth, (8-) 9-10.5 x 4.5-5 (-6) μm, with straight ventral germ slit spore-length (Figs. 6 and 7).

Asexual state belongs to genus *Lindquistia* Subram. & Chandrashekara. Synnemata associated with sexual state. Fertile part clavate, whitish, up to 1 mm diam, on blackish stipe ca. 0.5 mm diam, up to 3 mm total length (Fig. 3). Conidia and conidiogenesis as described for the genus.

SPECIMEN EXAMINED: CANARY ISLANDS: Gomera, San Sebastian de la Gomera, 17°03'W, 28°04'N, cultivated zone, 14.I.1990, Ing, B., rotten frond of *Phoenix dactylifera* L. (K:HOLOTYPE).

Lindquistia anamorphic state and culture of *P. ingii*. Figs. 2 - 4, 9-16.

Colonies on 2% oat meal agar at ca. 20° C under 12 h fluorescent light covering 9 cm diam Petri plate in 2 wk, with mycelium more or less tomentose, tawny to tan to brown. Reverse yellowish. Synnemata produced in 3-4 weeks (Fig. 2). Synnemata producing light to deep rose-colored to purplish pigmentation in 2% KOH.

Synnemata cylindrical to clavate, up to 2 cm high x 1-2 mm diam, tawny, with the stipe bearing conidia overall except for a basal portion. Hyphae of central stipe (2-) 2.5-4.5 (-5) μm diam, hyaline to yellowish. *Conidiophores* loosely arranged, branched, indeterminate in length, (1.5-) 2-4 (-5) μm diam, hyaline to yellowish, with many hyphal cells bearing one to several more or less globose,

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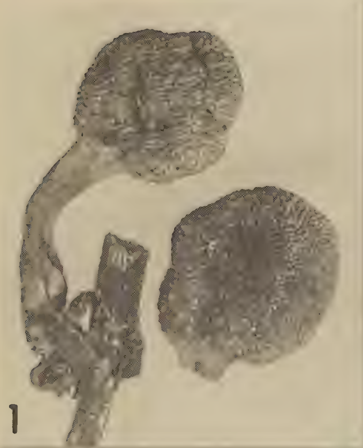
Figs. 1-8. *Podosordaria ingii* and its *Lindquistia* anamorph. 1. Teleomorphic stromata, X 2. 2. Culture showing synnemata near center, X 0.6. 3. Synnemata on natural substrate, X 12. 4. Orientation of hyphae in synnematal stipe, X 1000. 5. Ascus tip above ascospore, X 2200. 6. Ascospores showing germ slits, X 2200. 7. Ascospores, X 2200. 8. Detail of teleomorphic stromatal surface showing perithecial contours and ostioles, X 16.

Figs. 1-3, 8 by photomacrography. Fig. 4 by differential interference contrast micrography. Figs. 5-7 by brightfield microscopy.

Fig. 5 from material mounted in Melzer's reagent. Figs. 6 and 7 from material mounted in water.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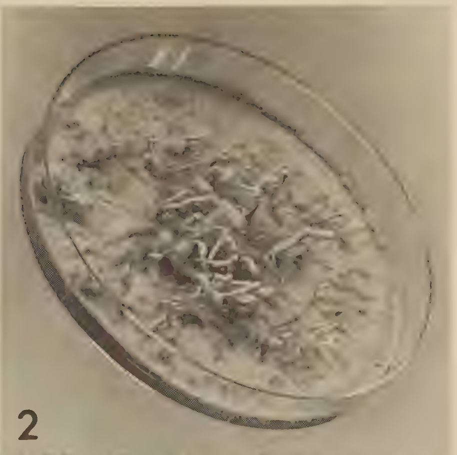
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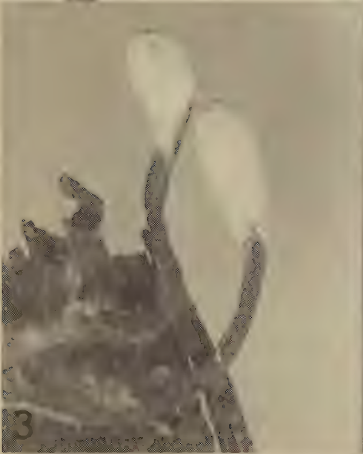
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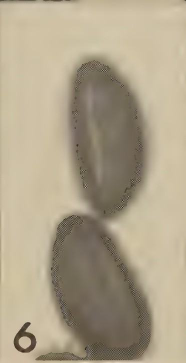
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sessile to subsessile conidiogenous cells (Fig. 16). *Conidiogenous* cells produced holoblastically, 3-4 µm diam, each cell producing one to several conidia holoblastically (Figs. 9, 10, 13-16). Conidiogenous cells eventually bearing one to several inconspicuous secession scars. *Conidia* hyaline, smooth, ellipsoid, obovoid, or globoid, with flattened bases, (2-) 2.5-4.5 (-5) x 2-3 µm (Figs. 11, 12, 14-16).

Cells of conidiophores and conidiogenous cells eventually disarticulating, forming a dusty mass composed of conidia, conidiogenous cells, and hyphal fragments (Figs. 12, 16).

Culture deposited in American Type Culture Collection as number 76588. Dried culture deposited in WSP and K.

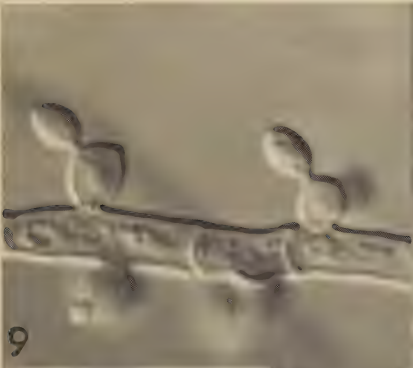
Podosordaria ingii has some features reminiscent of *P. jugoyasan* (Hara) Furuya & Udagawa. Conidiogenous cells and conidia of these species are very similar (Furuya and Udagawa, 1977). However, the latter species has much smaller stromata with more discoid fertile parts, occurs on hare dung, has ascospores with the germ slit conspicuously less than spore-length and a gelatinous sheath and, probably, bears its anamorph on the immature teleomorphic stroma as discussed later herein (see Furuya and Udagawa, 1977, for a description of *P. jugoyasan*). *Podosordaria ingii* likewise differs from *P. hircinia* (Tai & Wei) Krug & Cain, a species that has somewhat larger and darker ascospores and occurs on goat dung (Krug and Cain, 1974). The anamorph of *P. hircina* apparently has not been described.

Several taxa of *Podosordaria* and *Poronia* Willd.:Fr. have been reported from plant materials. *Poronia johorensis* (Morgan-Jones & Lim) Morgan-Jones has an anamorph with conidiogenous features much like those of *Podosordaria ingii*, but a teleomorph that differs greatly (Morgan-Jones and Hashmi, 1973; Morgan-Jones and Lim, 1968). *Poronia ustorum* Pat. has ascospores of the size range of *Podosordaria ingii*, but examination of type material [Patouillard no. 49, 1887. (FH)] corroborates Dennis' description (1957) [as *Xylaria ustorum* (Pat.) Dennis] of a fungus with much smaller white stromata. Some additional taxa that are probably related to *Podosordaria ingii*, but with much different ascospore characteristics are discussed elsewhere (Rogers et al., 1992).

Because of its *Xylaria*-like aspect attempts were also made to equate it with a named *Xylaria*. Biologically and taxonomically, however, its assignment must be to either *Poronia* or *Podosordaria*, based on the distinctive and characteristic *Lindquistia* anamorph (Rogers, 1985). Unfortunately, two influential publications have listed the anamorphs of *Poronia* species as *Xylocladium* Syd. (Carmichael et al., 1980; Kendrick and DiCosmo, 1979), a form-genus unlike *Lindquistia* in most important respects and inevitably associated with *Camillea* Fr.

Figs. 9-15. *Lindquistia* state of *Podosordaria ingii*. 9 and 10. Hyphae bearing conidiogenous cells, some of which bear conidia, X 1800. 11. Conidia, X 1800. 12. Disarticulated hyphae and conidiogenous cells and conidia, X 1000. 13. Hyphal cell bearing two conidiogenous cells, X 1900. 14 and 15. Conidiogenous cells bearing one to several conidia, X 7,000.

Figs. 9-13 by differential interference contrast microscopy. Figs. 14 and 15 by scanning electron microscopy.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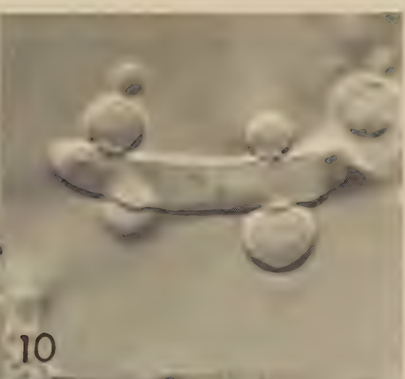
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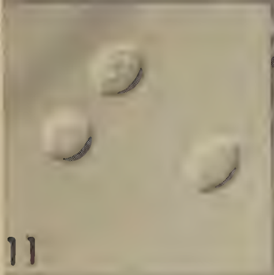
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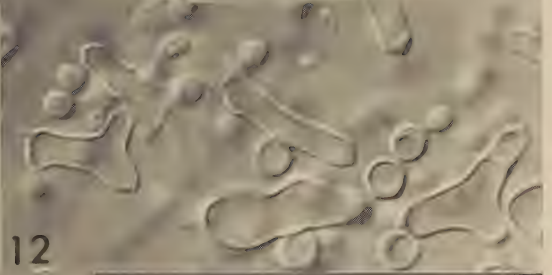
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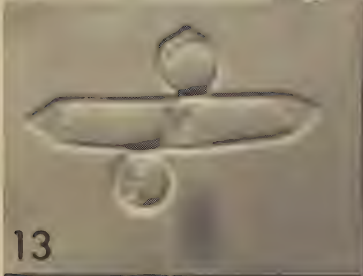
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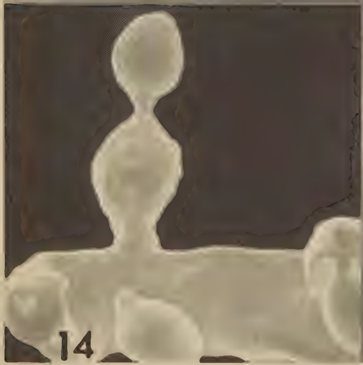
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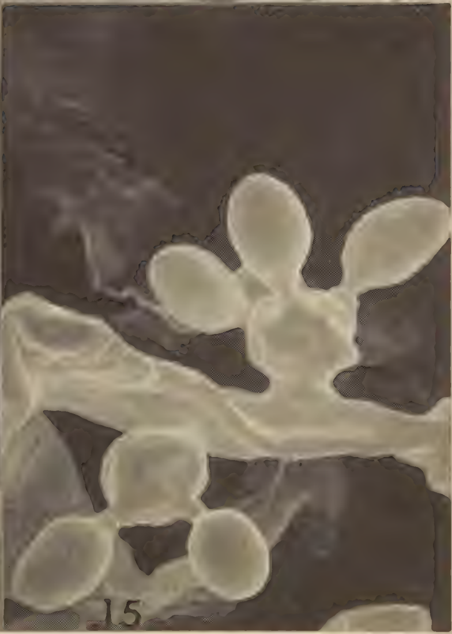
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species (Rogers, 1985). Distinctions between *Poronia* and *Podosordaria* are not clearly demarcated. *Podosordaria* was originally separated from *Poronia* on the convex surface of the fertile stroma of the former genus and the more or less plane surface of the latter. Martin (1970) greatly redefined and extended *Podosordaria* on the supposed lack of an ectostroma, including a number of traditional *Xylaria* species and some other lignicolous and graminicolous taxa. Krug and Cain (1974) restricted *Podosordaria* to coprophilous taxa and included two uniperitheciate species.

In general, we accept the Krug and Cain concept of *Podosordaria*, but include taxa that occur on substrates other than dung. Ironically and inconveniently, the type species of both *Poronia* and *Podosordaria* were described from dung and both genera include species that were collected from non-dung substrates (Morgan-Jones & Hashmi, 1973; Rogers et al., 1992). Limited cytological data suggest that *Poronia* and *Podosordaria* might be separated on nuclear condition of mature ascospores--binucleate or quadrinucleate in two investigated *Poronia* species (Rogers, 1970) and uninucleate in one investigated *Podosordaria* species (Rogers, 1973). It is likewise possible that further investigations will support uniting all taxa under the older name, *Poronia*, as already suggested by Koehn & Cole (1975).

Most *Podosordaria* and *Poronia* species grown in culture produce the *Lindquistia* state on the immature ascigerous stroma. The dusty products of conidiogenesis and disarticulation blow away and perithecial ostioles begin to appear on the upper stromatal surface. In *Podosordaria jugoyasan* stromata more or less morphologically typical of ascigerous stromata produced in nature are formed in culture, but these produce only the anamorph (Furuya & Udagawa, 1977). With this fungus, however, it is suspected that the teleomorph could be induced to develop from such stromata. In *Podosordaria ingii*, however, synnemata are produced along with the teleomorph in nature (Fig. 3). It is not known if synnemata are, in reality, incipient teleomorphs. Cultural evidence suggests, however, that the *Lindquistia* state is separate from the teleomorphic state in that it does not develop structures indicative of a teleomorph, even an immature one.

The synnemata produced in culture can be classified, as follows, using the recent anatomical system proposed by Seifert and Okada (1990). Synnemata are *indeterminate* in that the stipe continues to grow after sporulation begins. The central stipe is of *parallel* hyphae (Fig. 4), becoming of textura intricata as conidiophores diverge toward the periphery. The hyphal system is *monomitic*. The sporulating zone or capitulum is *divergent* (*loose*) to apparently *random*. This contrasts with the *hymenial* type of capitulum in many *Xylaria* species including the type where the conidiogenous cells are in a palisade.

The conidia of *Lindquistia* germinate readily, as do those conidiogenous cells and disarticulated hyphal cells that have not become devoid of cytoplasm

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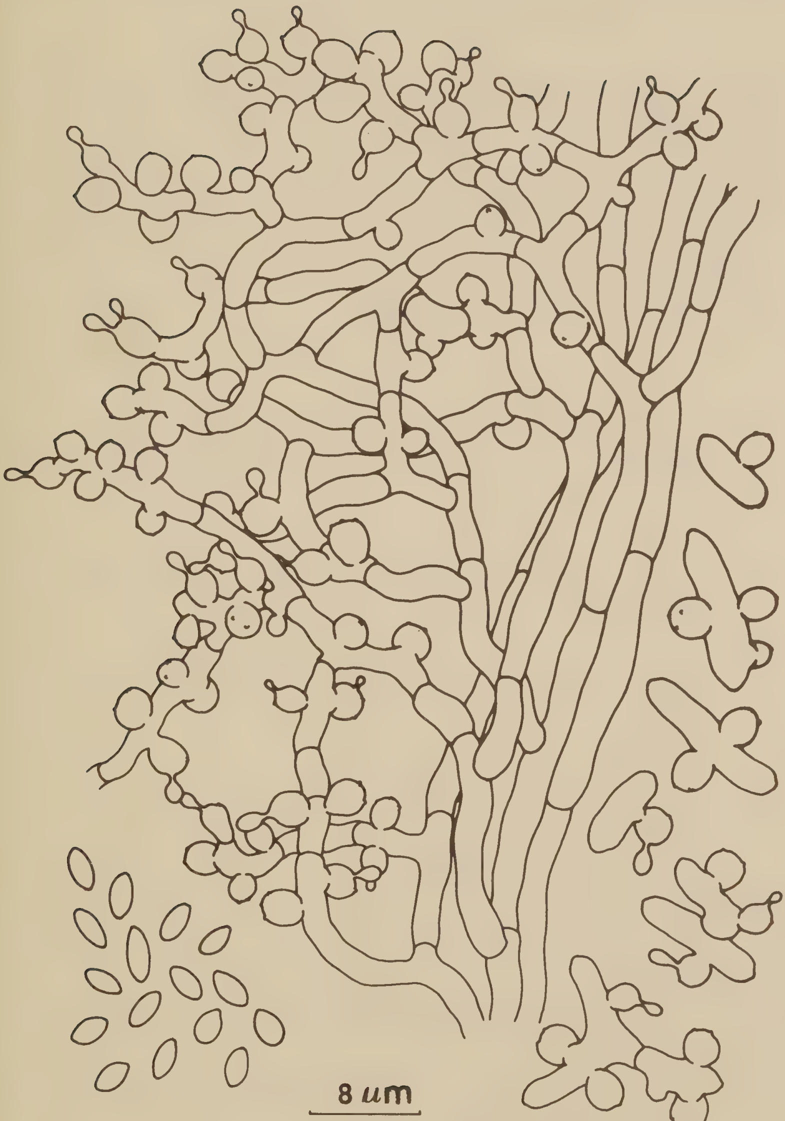
Fig. 16. *Lindquistia* state of *Podosordaria ingii*. Camera lucida depiction of conidiophores, conidiogenous cells, and conidia from culture. Drawing by Y.-M. Ju. Line = 8 μm.



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(Figs. 12 and 13). Ascospores likewise germinate readily without a requirement for heat activation as is usual for some other *Podosordaria* and *Poronia* species.

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ARTHROBOTRYS FEROX SP. NOV., A SPRINGTAIL-CAPTURING HYPHOMYCETE FROM CONTINENTAL ANTARCTICA

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Abstract

In studies of the mycoflora in Victoria Land of Continental Antarctica, a species of *Arthrobotrys* , which has not been described previously, was discovered. This Hyphomycete, proposed here as a new species under the name of *A. ferox*, produces aerial predaceous organs consisting of ovoidal cells surrounded by an adhesive secretion and supported by a 2-celled stalk. Frequently, it was observed capturing springtails belonging to the Antarctic species *Gressittacantha terranova* Wise by means of these organs.

Introduction

During the Italian Antarctic Expeditions, a species of *Arthrobotrys* was isolated from the moss species *Bryum algens* Card. and *Ceratodon purpureus* (Hedw.) Brid., collected in Kay Island, Edmonson Point and Baker Rocks (Wood Bay, Victoria Land, Antarctica) (Onofri & Tosi, 1989; Onofri & Tosi, 1990; Tosi *et al.*, 1990). This Hyphomycete produces interwoven aerial hyphae that carry ovoidal cells supported by 2-celled stalks and surrounded by an adhesive secretion. These vesicles are able to capture relatively large springtails of the species *Gressittacantha terranova* Wise (about 1.2 mm in length). Arthropods are seldom captured by predaceous fungi. Among Hyphomycetes only *Arthrobotrys entomopaga* Drechsler produces stalked adhesive vesicles, sorrounded by an adhesive mucilage, which are able to capture small springtails (0.35 mm in length) of the genus *Sminthurides* (Drechsler, 1944). This species was neotypified (van Oorschot, 1985) by the type isolate of *A. pauca* J.S. McCulloch described as producing adhesive spherical knobs without a mucous secretion surrounding it and capturing nematodes (McCulloch, 1977).

Some species of other genera also have adhesive vesicle-like capture organs; among them *Dactylella*, *Monacrosporium* and *Nematoctonus* (the latter is characterized by clamp connections): none of the species in these genera is known as springtail predator.

The species here described frequently presents branched conidiophores; within *Arthrobotrys* only *A. arthrobotryoides* (Berlese) Lindau, *A. cladodes* Drechsler, *A. robusta* Duddington (Haard, 1968) and *A. botryospora* Barron (Van Oorschot, 1985) possess branched conidiophores, but they have conidia of different shape *(A. arthrobotryoides)* , dimensions *(A. cladodes)* and both shape and dimensions *(A. robusta)*, conidia produced only at the apex of the conidiophore and its branches *(A. cladodes)* , different conidiophore shape *(A. robusta)* or typically aseptate conidia *(A. botryospora)*. Moreover, some of them are known to be nematophagous and form adhesive loops as organs of capture. Among the species with unbranched conidiophores, the conidia of the present species have some morphological affinities with *A. superba* Corda, (but the latter possesses conidia not constristricted at the septum) and with *A. oligospora* Fresenius which captures nematodes by means of a tridimensional network, lacks vesicles and has conidia with the distal cell distinctly longer than the proximal one. The vesicles of this Antarctic Hyphomycete are similar to those of *A. entomopaga*, which measure 6-10 µm (Roxon & Jong, 1975), but they are larger and normally supported by 2-celled, instead of 1-celled stalks. Moreover, it differs from the species here described, in the unbranched conidiophores that present peg-like sterigmata, in producing conidia tapering to a protruded base and not constricted at the septum. On the base of these observations, we therefore propose a new species in *Arthrobotrys* Corda emend. Schenck, Kendrick & Pramer (1977) to accommodate our isolates.

This species is the first predaceous hyphomycete collected in Continental Antarctica, the first springtail-predaceous one in the Antarctic Continent (Gray, 1982; Gray *et al.*, 1982; Gray & Lewis Smith, 1984) and the second springtail-predaceous Hyphomycete known.

Arthrobotrys ferox Onofri & Tosi, sp. nov.
Etym.: *ferox*, ferocious.

Coloniae in CYA albae vel deinde tarde luteo-roseae. Mycelium hyalinum; hyphae repentes et aeriae, 4.5-6.5 µm crassae, intervallis 22-35(-45) µm septatae. Conidiophora macronematosa, mononematosa, erecta, septata, saepe ramosa, (33.5-)44-144(-466) µm longa, prope basim 5-7 µm crassa et apicem versus 3-4 µm, (2-)4(-10) conidia e denticulis 2-

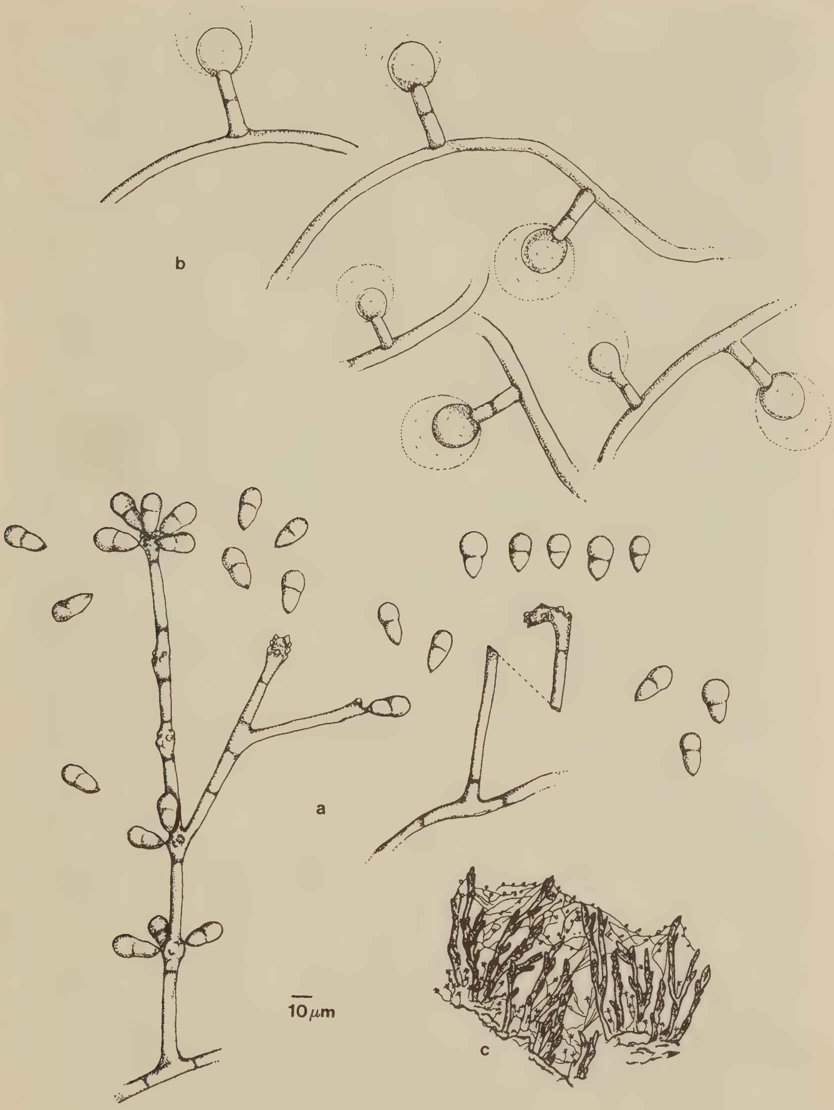

Fig. 1. *Arthrobotrys ferox* ROHB 400 A. a) Conidiophores and conidia. b) Aerial hyphae with predaceous organs. c) Habit sketch (on natural substratum).

4.5 µm longis formantia. Conidia hyalina, obovata-clavata, in medio 1-septata, ad septum modice constricta, (13-)15-18(-24.5)x(5-)6-8(-9) µm.

Collembola (*Gressittacantha terranova* Wise) depraedans; ex hyphis aereis ramuli bicellulares oriuntur qui vesiculam ovoideam adhaesivam (18-)20-25(-31)x(16.5-)17-21(-24.5) µm formant, involucro glutinis circumdatam.

In musco *Bryum algens* Card., Edmonson Point, Wood Bay, Terra Victoria, Antarctica (quo continentem attinet), G. Del Frate, 23 Feb. 1988, ROHB 400A, holotypus, cultus CBS 245.91.

Colonies on Czapek yeast agar white to pale pink-orange, mycelium hyaline; repent and aerial hyphae, 4.5-6.5 µm wide, septate at intervals of 22-35(-45) µm. Conidiophores macronematous, mononematous, erect, septate, often branched, (33.5-)44-144(-466) µm long, 5-7 µm wide at the base and 3-4 µm farther upward, producing (2-)4(-10) conidia on 2-4.5 µm long denticles. Conidia hyaline, obovoidal to clavate, 2-celled, 1-septate, slightly constricted at the septum which is usually in the middle, (13-)15-18(-24.5)x(5-)6-8(-9) µm. Predatory on springtails *(Gressittacantha terranova)* ; aerial predaceous organs consisting of ovoidal cells, (18-)20-25(-31)x(16.5-)17-21(-24.5) µm, surrounded by an adhesive secretion and supported by a commonly 2-celled stalk, (9-)14-24(-34)x4.5-7 µm. It grows well at room temperature.

Specimens examined. All were collected on mosses of *Bryum algens* Card. and *Ceratodon purpureus* (Hedw.) Brid., in Wood Bay, Victoria Land, Continental Antarctica: ROHB 400A (holotype), Edmonson Point, 23 Feb. 1988, G. Del Frate; ROHB 401A and ROHB 402 A, Baker Rocks, 26 Dec. 1988, S. Onofri; ROHB 403A, Edmonson Point, 29 Dec. 1988, S. Onofri; ROHB 404A, 5 Jan. 1989, G. Carchini; ROHB 405A, Kay Island, 16 Jan. 1989, S. Onofri.

Two strains are deposited in the CBS culture collection: CBS 245.91 ex holotype of ROHB 400A; CBS 137.91 ex ROHB 404 A.

Discussion

Among the predaceous fungi only species of *Arthrobotrys* are known to capture springtails (Drechsler, 1944). *Arthrobotrys* contains about 25 predaceous species; and vesicles are produced only by *A. entomopaga* .

It is very difficult to induce the production of predaceous organs of *A. ferox* in pure cultures. In fact we obtained the production of vesicles in pure culture only once, observing a predaceous organ produced in a pure culture obtained from the specimen ROHB 404A of *A. ferox*, growing on cornmeal agar, after one year of cultivation (fig. 2 d). On the Antarctic mosses, directly observed just after collection or after maintenance in a moist chamber, it was possible to find conidiophores and aerial hyphae

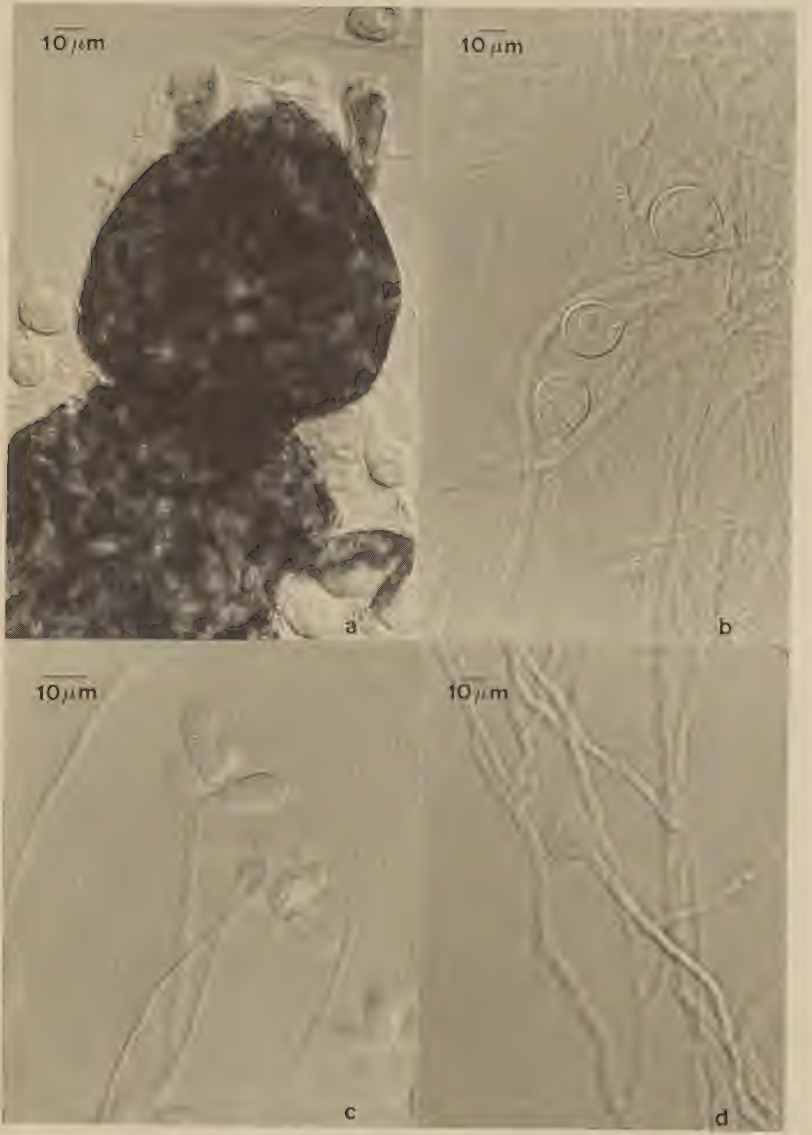

Fig. 2. a) Fore-end of the springtail *Gressittacantha terranova* sorrounded by the vesicles of *Arthrobotrys ferox*. b) Vesicles from the natural substratum. c) Conidiophores and conidia of *Arthrobotrys ferox* in pure culture on CYA. d) Vesicle in pure culture on cornmeal agar.

bearing vesicles closely associated. A constant pattern of two kinds of mycelium was observed on the moss: the interwoven reproductive hyphae were always supported by a repent mycelium, whilst the predaceous structures were only seen on the aerial hyphae. This spatial arrangement appears to be most efficient for the capture of springtails. Morphological analysis shows that the repent and aerial hyphae are microscopically very similar.

On this evidence we conclude that the vesicles belong to *A. ferox*. This suggestion seems to be further corroborated by the fact that in the investigated area, no other species of the predaceous genera has ever been found.

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MYCOTAXON

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RIMULARIA CAECA, A CORTICOLOUS LICHEN SPECIES FROM NORTH AMERICA

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ABSTRACT: On examination the North American corticolous *Lecidea caeca* was found to be a member of the genus *Rimularia* (Rimulariacae, Lecanorales). The species is described there in detail.

KEYWORDS: *Lecidea*, Lecanorales, lichens, flora of North America, *Rimularia caeca*.

INTRODUCTION

Since ascus structures have been found to be highly valuable diagnostic characters in lecideoid lichens, many changes have occured in the taxonomy of this unnatural group of species. This, however, have mostly concerned the saxicolous members of *Lecidea* s.l., presently placed in several new or re-established genera (see e.g. HERTEL 1984, HERTEL & RAMBOLD 1987, 1990).

The actual knowledge about the taxonomy of the corticolous, terricolous and muscicolous taxa is still very poor. No modern monograph of this very heterogenous group yet exists. In recent years, the relationships of just a few corticolous or terricolous lecideoid taxa have been discussed within only a few smaller contributions, e.g. in COPPINS & JAMES (1984), HINTEREGGER & al. (1989), or TØNSBERG (1990).

It recently became clear, that *Lecidea* s.str. is an exclusively saxicolous genus, restricted to calciferous and siliceous rock, and does not grow on organic substrates. Some of the corticolous lecideoid species belong to *Biatora*, *Lecanora*, *Lecidella* and other genera of the Lecanoraceae s.l. like *Protoparmelia* or *Pyrrhospora*. There is also a high number of corticolous lecideoid species, which belong to genera of the suborder Cladoniineae sensu RAMBOLD et al. (1992). They have different ascus structures and belong to families like the Micareaceae, Agyriaceae (incl. Trapeliaceae) and Rimulariaceae. A member of the latter group is the North American species *Lecidea caeca*, which was found to belong to the world-wide distributed genus *Rimularia*.

We would like to thank Prof. Dr. H. Hertel (München) for revising the manuscript and various help. Particular thanks are due to Dr. C.M. Wetmore (Minnesota), the first lichenologist after LOWE who recognized *R. caeca*, for his comments on the ecology of this species. He made available to us numerous (all correctly determined) collections, which form the basis of our description and discussions. We thank Dr. A. Taylor (München) for improving the English text and Miss B. Rambold (München) for making the habit drawings. We are also most grateful to the curators of the herbaria M, MICH and MIN. For financial support we gratefully acknowledge grant He 953/5-1 from the Deutsche Forschungsgemeinschaft (DFG).

THE SPECIES

Rimularia caeca (Lowe) Rambold & Printzen **comb. nova**

≡ *Lecidea caeca* Lowe, *Lloydia* **2**(4): 244-245 (1939). - Type: U.S.A.: New York, Essex Co., Adirondack region, Chapel Pond (near St. Huberts), 1600 ft, on white pine on talus slope, *J. L. Lowe* 5533 (MICH! - holotype).

Description: **Thallus** crustose, mostly epiphloeodic, up to 2 cm diam., white to sordid olive, composed of rounded, weakly convex, confluent verrucules, sometimes combining to form small areolae. *Verrucules* c. 0.1-0.2 mm diam. Thallus occasionally sorediate (observed in about 25 % of the specimens). *Soredia* dark brown and somewhat glossy, 15-25 µm; soredial hyphae short-celled, brown pigmented. *Soralia* rounded, mostly small, 0.1-0.25 mm diam. and ± confluent, rarely 0.2-0.45 mm diam. and well-delimited. Thallus margin often indistinct and overgrowing adjacent thalli of other crustose lichens. In section, thallus c. 60-150 µm thick, poorly differentiated. Epinecral layer 5-20 µm, sometimes lacking; uppermost cell layer sometimes brownish; algae trebouxioid, 8-18 µm diam., densely entangled by more or less isodiametric hyphae. **Apothecia** sessile, 0.25-0.45(-0.6) mm diam., round to strongly flexuose, single, rarely in groups of 2-3, up to more than 300/cm^2, mostly regularly distributed over the thallus. *Disc* flat to weakly convex, black, with matt, epruinose surface. *Margin* persistent, 0.02-0.05 mm thick, black, matt. *Excipulum* 20-30 µm, max. 40 µm, pseudoparenchymatic; ectal zone dark brown, 10-20(-30) µm, with hyphae of 2.5-6 µm diam. and lumina of 1.5-4 µm diam.; inner zone colourless and more or less plectenchymatic. *Hypothecium* colourless, 40-60(-70) µm, with densely interwoven, short-celled hyphae of 2-4 µm diam. *Hymenium* colourless to sordid greenish, 40-60 µm, I_{Lugol} + greenish-blue to sordid-brown, $I_{Lugol\ 1:6}$ + blue, K- or K+ rose red to violet; epihymenium dark brown, sometimes with an olive tinge, 5-15(-20) µm. *Paraphyses* frequently branched and anastomosing, short-celled, moniliform, (1.5-)2-3 µm diam., lumina 1-2 µm; apical cells (3-)3.5-5.5 x 2.5-5.5 µm, lumina 2-4 µm. *Asci* of *Rimularia*-type, 8-spored, 30-40 x 9-14 µm; length-width-index: 1:2.5-3.5(-4); amyloid wall layer c. 0.5 µm thick, I_{Lugol} + greenish-blue to orange-brown, $I_{Lugol\ 1:6}$ + blue,; non-amyloid wall layer c. 1.0 µm thick; tholus max. 6-8,5 µm, min. 2-6 µm high. *Spores* ellipsoid, colourless, non-septate, 7.5-**10.5**-13.5 x 4.5-**5.5**-7.5 µm; length-width-index 1:1.5-2 (-2.4), wall c. 0.5 µm thick. **Pycnidia** not observed.

Chemistry: TLC method according to CULBERSON & AMMANN (1979): 1) 16 of 32 specimens examined containing unidentified substance 'C-1' as major substance (often in low concentrations). [Unidentified substance 'C-1': R_f-classes A:2; B:3; C:2; DL: not visible; H_2SO_4 + pale yellow; AS-; UV_{254} +; UV_{350} + whitish blue; after spraying with H_2SO_4 and charring, UV_{350} + olivaceous.] 2) 16 specimens containing no detectable substances.

Ecology and distribution: *R. caeca* is hitherto known only from the temperate part of eastern North America, and was collected mainly in the Great Lakes area (see also WETMORE 1981). This probably often overlooked species grows on the bark of conifers like *Abies balsamea* (balsam fir), *Larix laricina* (tamarack), *Picea glauca* (white spruce), *Picea mariana* (black spruce), *Pinus banksiana* (jack pine), *Pinus rigida* (pitch pine), and *Pinus strobus* (white pine). One specimen was found to grow on a birch snag (*Betula* sp.).

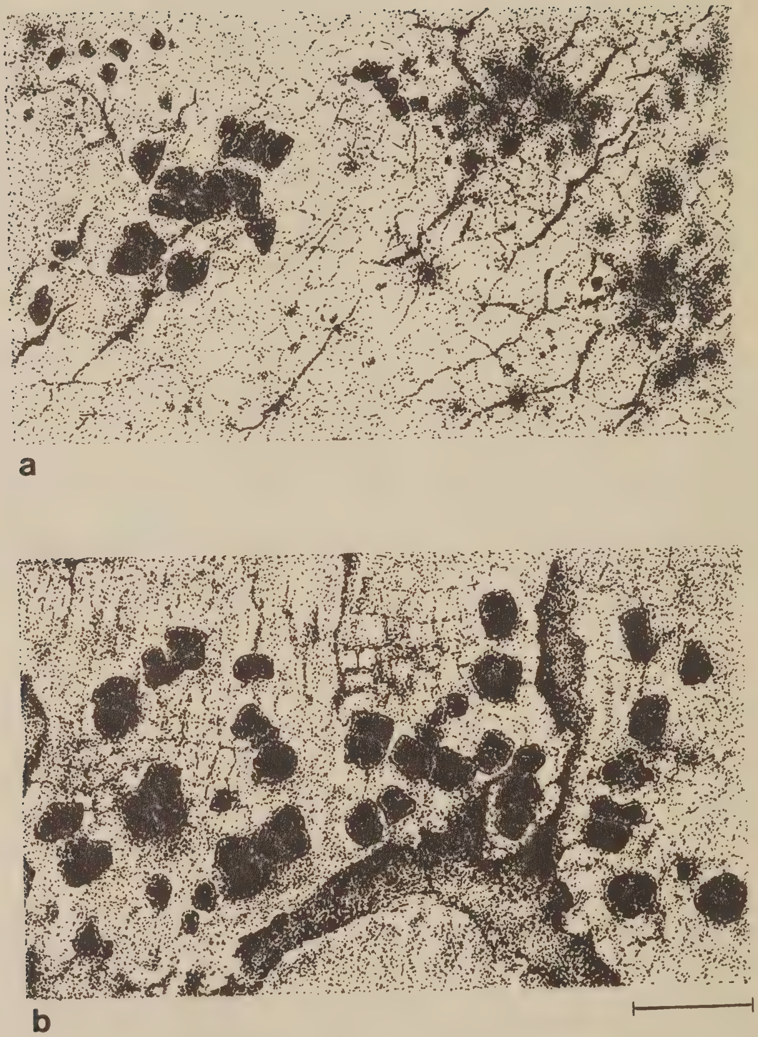

Fig. 1: *Rimularia caeca* (habitus) on bark **a**) specimen with apothecia (left) and sorediate parts of the thallus (right): *C.M. Wetmore* 22850, MIN. **b**) non sorediate specimen: *C.M. Wetmore* 58728, MIN. Scale: 1 mm.

Selected specimens: CANADA: NEWFOUNDLAND, 1.6 km SW of Conne River Pnd (35 km N of Miltown), [c. 48°10'N, 55°47'W], in sloping bog with pools, on tamarack, 26 VI 1981, *C.M. Wetmore* 42915 (MIN).

NEW BRUNSWICK, Chance Harbour, 35 km SW of St John, 1.6 km S of Chance Harbour in small open bog, [c. 45°05'N, 66°25'W], on tamarack, 6 VII 1981, *C.M. Wetmore* 43403 (MIN).

U.S.A.: MINNESOTA, St Louis Co., Voyageurs National Park, N of Agnes Lake E of Lost Bay on Kabetogama Lake, [c. 48°26'N, 93°01'W], on rocky ridges with jack pine and thick young balsam fir, on jack pine, 17 VI 1978, *C.M. Wetmore* 33613 (MIN). – Boundary Waters Canoe area, just E of Bezhik Creek, SE of Seranade Lake, 17 mi NW of Ely, [48°23'N, 92°05'W], black spruce bog, with a few tamarack, balsam fir, and paper birch along the border, on white pine, c. 1400 ft, 7 IX 1986, *T.D. Trana* 13407, 13446 (MIN). – E of Tomahawk Camp, 5 mi SE of Babbitt, [c. 47°35, 91°48'W], in middle age jack pine stand, on spruce, 11 VI 1977 *C.M. Wetmore* 27267 (MIN). – Near St Louis River, 3 mi S of Hoyt Lakes, white spruce plantation planted in 1940, on white spruce, 8 IX 1977, *C.M. Wetmore* 30255B (MIN). – Cook Co., Seagull Creek near end of Gunflint Trail, 40 mi N of Tofte, [c. 48°10'N, 90°50'W], around shaded rock outcrop, on jack pine, 2 VII 1974, *C.M. Wetmore* 22650 (MIN). – Lake Co., 13 mi E of Ely, on Hwy 18 (Fernberg Rd), [c. 47°50'N, 92°05'W], around rock outcrop and mixed conifer hardwood forest, on jack pine, 25 VIII 1973, *C.M. Wetmore* 21893 (MIN). – S of Stony Creek, 17 mi SSE of Ely, [c. 47°45'N, 91°48'W], in mature jack pine stand on ridgetop, on fallen branch, 10 VI 1977, *C.M. Wetmore* 27206A (MIN). – N of Stony River, 9 mi E of Babbitt, [c. 47°40'N, 91°40'W], in jack pine plantation planted in 1959, on jack pine, 12 VI 1977, *C.M. Wetmore* 27433B (MIN). – 7 mi ESE of Babbitt, Tomahawk Rd, [47°40'N, 91°51'W], in tamarack swamp with young trees, on tamarack, 14 VI 1977, *C.M. Wetmore* 27633 (M, MIN). – Hubbard Co., 1 mi N of Lake George, in jack pine area in open second growth pines, on jack pine, 24 VII 1974, *C.M. Wetmore* 22850 (MIN).

MICHIGAN, Alger Co., Pictured Rocks National Lakeshore, N side of Grand Sable Lake, 2 mi W of Grand Marais, [c. 46°39'N, 86°05'W], on ridges with jack pines and openings, on jack pine, 10 VII 1987, *C.M. Wetmore* 58728 (MIN). – Pictured Rocks National Lakeshore, 0.5 mi S of Twelvemile Beach Campground, in jack pine forest near junction of campground road and Hwy 58, on jack pine, 13 VII 1987, *C.M. Wetmore* 58951 (MIN).

MAINE, Washington Co., Machias bog, 10 mi SE of Machias, [c. 44°40'N, 67° 35'W], in bog with shrubs and black spruce and tamarack, on black spruce, 20 VI 1981, *C.M. Wetmore* 42635 (MIN). – Hancock Co., Acadia National Park, Mt Desert Isl. E of Great Meadow Marsh (1 mi S of Bar Harbour), [c. 44°19'N, 68° 14'W], at base of cliff in maple birch, oak woods along rock outcrops with oak and pitch pine, on pitch pine, 5 VII 1983, *T.J. Sullivan* 1302 (MIN). – Acadia National Park, Mt Desert Island, S of Upper Hadlock Pond, in maple spruce and *Thuja* woods with some balsam fir, birch and aspen, on birch snag, 3 VII 1983, *T.J. Sullivan* 1172 (MIN).

DISCUSSION

R. caeca is a further corticolous representative of the genus *Rimularia*, which hitherto comprises species growing on siliceous rocks (lichenicolous or saxicolous), bryophytes, and bark. It is a small and inconspicuous lichen.

R. caeca is easily identified as a species of the genus *Rimularia* by its flexuose apothecia, the short-celled paraphyses and hyphae of the excipulum, hypothecium, the vegetative thallus, and the distinctive asci of the *Rimularia*-type (see HAFELLNER 1984: 332, fig. 77). Dark brown soralia with glossy soredia are developed only facultatively (nine out of 38 specimens examined). Soralia of this type are also typical for other sorediate species of *Rimularia*, like *R. furvella*. Sorediate specimens without apothecia, which may occur in nature, are not known to us. Within the genus, the species is characterized by persistently hyaline, ellipsoid spores, the contents of the unidentified substance "C-1" and its occurrence on conifer bark.

Because there are no corresponding anatomical features, sorediate and non-sorediate specimens, are regarded as conspecific. In our opinion, the lack of detectable amounts of the substance "C-1" in 50 % of the examined specimens does also not justify the separation of two taxa.

The species strongly resembles the sorediate *R. fuscosora*, recently described by MUHR & TØNSBERG (1989) from northern Europe, but differs in having smaller spores (*R. fuscosora*: (9.5-)11-16(-20) x (5-)7-11 µm) and a positive K-reaction of the hymenium. The rose red to violet colour reaction is often very weak and sometimes missing at all. However, hymenia with a sordid green tinge give a strong and lasting violet reaction. The two species are also separated by their chemistry, *R. caeca* contains the unidentified substance "C-1", while *R. fuscosora* has norstictic acid. In addition to their different distribution, chemistry, and spore size, they prefer different substrates: the European *R. fuscosora* seems to be restricted to the bark of deciduous trees (*Alnus incana*, *Betula* sp.), whereas the North American *R. caeca* (with one exception) was found on conifers, mostly on *Pinus banksiana* (jack pine).

No closer relations are assumed with the tropical *Rimularia globulispora* Aptroot & Sipmann, described from Papua New Guinea, which is a muscicolous (type found on *Frullania* sp.) or corticolous species. It has globose spores and contains lobaric acid (APTROOT & SIPMAN 1991).

R. caeca is the eighth species of *Rimularia*, recognized for the North American flora. From there, reports exist already for the two lichenicolous taxa *R. furvella*, *R. insularis*, for the saxicolous *R. badioatra*, *R. gibbosa*, *R. gyrizans*, *R. impavida*, and the muscicolous *R. sphacelata* (EGAN 1987, 1989, 1991).

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COMPARATIVE MORPHOLOGICAL STUDIES OF DISCOSIA ARTOCREAS AND DISCOSIA FAGINEA

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ABSTRACT. Comparative morphological studies on the original specimens of Discosia artocreas (Tode) Fr. and D. faginea Lib. were carried out. The results proved that D. artocreas and D. faginea are two separate species. D. artocreas is a type of genus Discosia.

Genus Discosia was described by Libert in 1837 and it comprises imperfect fungi belonging to order Sphaeropsidales of class Coelomycetes. In the diagnosis of the original species Discosia faginea, Libert (1837) indicates Sphaeria artocreas Tode (a species described by Tode in 1791) as a synonym of D. faginea. Later Fries (1849), considering S. artocreas an individual species from genus Discosia, suggests the new combination Discosia artocreas (Tode) Fr.

While we revised taxonomically genus Discosia in the period 1975-1991, a number of obscure questions arose on the taxonomic status and the nomenclature of D. faginea and D. artocreas, bearing a direct relation to the determination of the type species of the genus Discosia. For example, in case Libert's position is accepted that D. faginea and D. artocreas are synonymous names of a common species, then, under article 55 of the International Code of the Botanical Nomenclature, priority is given to the older epithet of the species, i.e. "artocreas". On the other hand, Fries (l. c.), referring S. artocreas to genus Discosia was obviously acquainted with Libert's work, but in the original description of the new combination there is no mention of the indicated relation between *D. faginea* and *D. artocreas*,therefore it might be assumed he considers the two species to be independent.

Subramanian and Reddy (1974) have not studied the original specimens of *D. faginea* and *D. artocreas*, therefore they have no position as regards the taxonomy and the nomenclature of the two species.

The main difficulty when elucidating the taxonomic status of *D. faginea* and *D. artocreas* is due to the fact the original specimen of *Sphaeria artocreas* is considered to be destroyed or lost, that preventing the investigators, so far, from expressing an opinion on the problem of whether the two species are good ones, or we have to do with synonyms (Sutton, 1980).

In 1981, while revising herbarium materials from the Herbarium at the Royal Botanical Gardens, Kew, England (K), we came across the original specimen of *S. artocreas* from Fries's collection, marked: "Scleromyceti Sueciae No 151. *Sphaeria artocreas* Tode" (Fig. 1).

Having that material, together with the original specimen of *D. faginea* from Libert's Mycological collection, kindly placed at our disposal by the Herbarium at the National Botanical Garden in Brussels, Belgium (BR), we carried out comparative morphological studies on both specimens, the result of which provided us with a possibility to take a definite position with respect to the question discussed.

MATERIAL AND METHODS

In conformity with the modern taxonomic criteria, accepted in the systematics of the imperfect pycnidial fungi from class *Coelomycetes* (Sutton, l. c.) we based our comparative investigations on the morphology of the conidiogenous apparatus (pycnidia, conidiogenous cells), and the conidia of the original herbarium specimens of *D. faginea* (ex BR) and *D. artocreas* (sub *Sphaeria artocreas*-

ex K).

The dimension, the colour and the shape of the conidia as well as the exact position of the conidial septa and appendages were used as the basic systematic features in the comparative morphological characteristics of the studied specimens. The cited morphological elements were studied in lacto-phenol semistable preparations under Amplival light microscope, after the passing-light method. Conidiogenous cells and conidia were observed and photographed using Leitz-AMR-1000 A scanning electron microscope. For the precise investigation of the conidiogenous process and the structure of the generative organs, using a freezing microtome, thin cuts of pycnidia were made (having a thickness of about 10 µm), covered in paraffin.

Studied were also live liophylized specimens of D. faginea (strain CBS 443.67) and D. artocreas (strain CBS 241.66), preserved in the Centraalbureau voor Schimmelcultures, Baarn, The Netherlands. The live specimens were cultivated setting conidia cultures on oatmeal agar in Petri-dishes, and then exposed at a constant temperature of 24°C. The outward appearance and the diameter of the colonies were compared 3, 6, 9 and 12 days after setting the culture.

Traced out was the influence of the temperature on the growth of the colonies of both strains on oatmeal agar in Petri-dishes at a temperature of 3, 6, 15, 21, 24, 30, 33 and 36°C in a serial thermostat, as a result of which the temperature requirements were determined for the growth and spore-formation of the strains studied.

All the variants of the experimental investigations were carried out three times repeatedly.

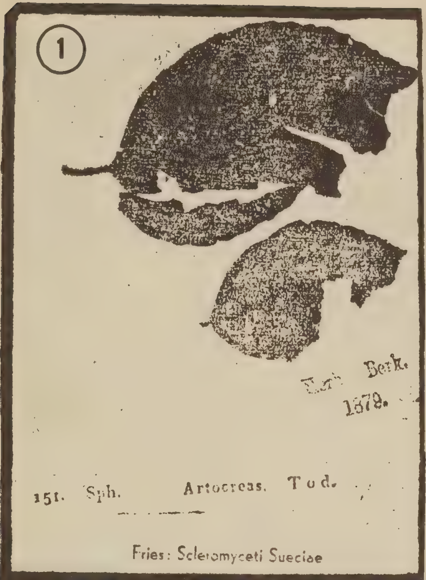
RESULTS AND CONCLUSIONS

As a result of the comparative investigations carried out on the original herbarium specimens of D. faginea and D. artocreas, as well as on live cultures of these fungi, we established considerable morphological, cultural and physiological differences between them, to be considered successively.

1. MORPHOLOGY OF THE CONIDIA. The conidia of the fungi of genus *Discosia* have characteristic shape, structure and dimensions, the genus being well differentiated as a separate group on the base of those features. On the other hand, within the limits of the genus to be observed are considerable differences in the structure of the conidia, the fact providing a possibility for the differentiation of intra-generic taxa of various ranks.

According to the position of the conidial appendages and the relative length of the conidial cells, 6 sections were differentiated within the limits of the genus (Vanev, 1991). It was established that the original specimens of *D. faginea* and *D. artocreas* share common features, referring them to the common Section I. *Discosia*, more particularly: the conidial appendages are adjacent to the apex and the base of the conidia, the two middle cells being of different length - the cell, adjacent to the base is always longer than the one adjacent to the apex. Regardless of the common features cited, others exist, in which the conidia of the studied specimens differ considerably from each other. On fig. 2 it is obvious that *D. faginea* has considerably wider conidia than the ones of *D. artocreas*. Differences are also to be observed in the shape - with *D. artocreas* predominating are cylindrical conidia having cells of equal width and colour, while with *D. faginea* the majority of the conidia are spindle-shaped, the two middle cells being wider and darker in colour than the two end cells. In the conidia of *D. artocreas* the middle cell adjacent to the base is always twice or more times longer than the other middle cell, adjacent to the apex, while in the conidia of *D. faginea* the difference in the length of the two middle cells never reaches 2 : 1 (Fig. 4).

2. MORPHOLOGY OF THE CONIDIOGENOUS CELLS AND THE PYC-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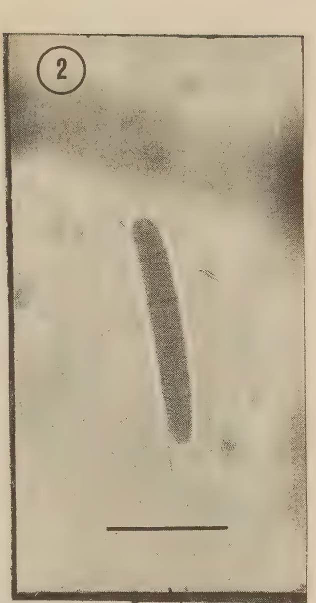
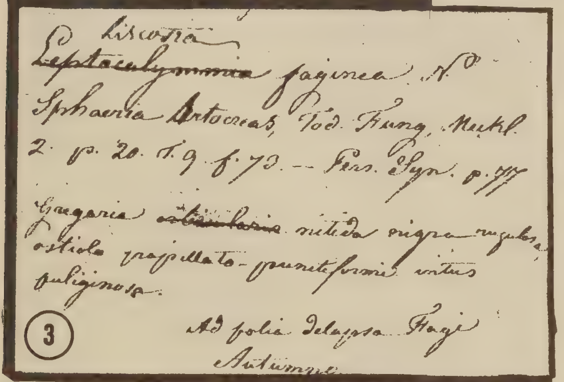
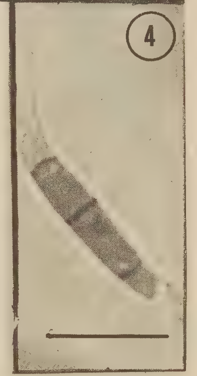
Berk.
1879.
151. Sph. Artocreas. Tod.
Fries: Scleromyceti Sueciae

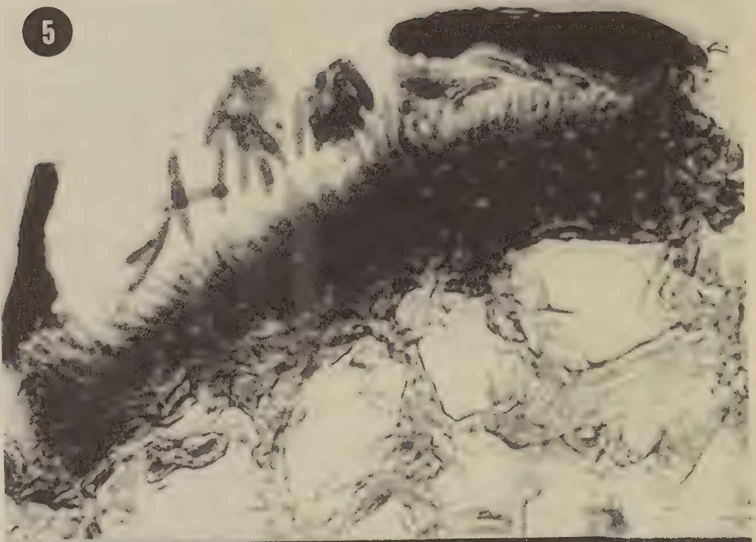




Discosia
~~Leptocalymma~~ faginea N.
Sphaeria Artocreas, Tod. Fung. Meckl.
2. p. 20. t. 9. f. 73. -- Pers. Syn. p. 77
Gregaria ~~orbicularis~~ nitida nigra rugulosa,
ostiolo papillato-punctiformi intus
fuliginosa.
Ad folia delapsa Fagi
Autumno



Figs. 1-2. Discosia artocreas: 1. Original specimen. 2. Conidium. Figs. 3-4: Discosia faginea: 3. Original description. 4. Conidium. Scale bars = 10 µm.



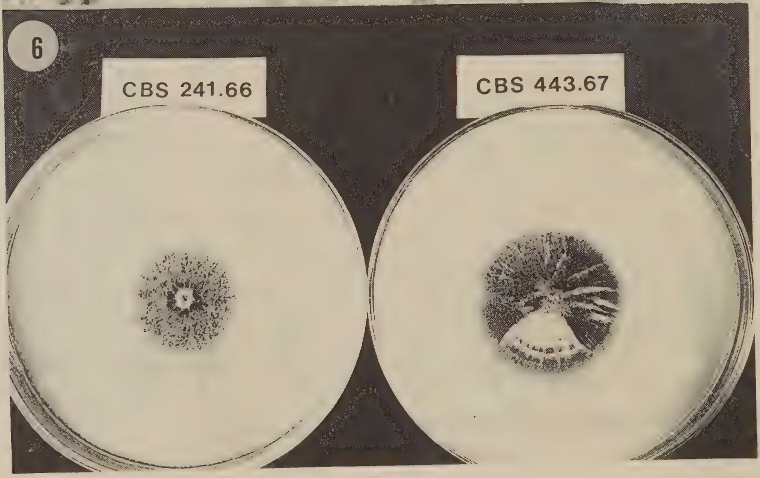

6
CBS 241.66
CBS 443.67

Fig. 5. Longitudinal pycnidial cut of Discosia faginea.
Fig. 6. Colonia of Discosia artocreas (CBS 241.66) and Discosia faginea (CBS 443.67) at 24°C.

NIDIA. The conidiogenous cells of the fungi from genus Discosia form on a stromatic base within the pycnidia (Fig. 5). They are of a varying shape and length, altering within rather wide limits, due to which their taxonomic value is relatively limited. Studying completely developed pycnidia, certain differences were established in the structure of the conidiogenous cells of *D. artocreas* and *D. faginea*: in the pycnidia of the former species relatively short (up to 8 µm) conidiogenous cells are formed, most often cone-shaped, while with the latter species those cells are longer (up to 15 µm), being predominantly cylindrical or bottle-shaped.

Studying longitudinal pycnidial cuts from both species, it was established that with *D. artocreas* the pycnidia are most often pluriloculate, flat or slightly concave at the centre, with a convex margin and a relatively thin stromatic base, while with *D. faginea* the pycnidia are monoloculate, disc-shaped, convex in the middle and having a thicker stromatic base.

3. CULTURAL CHARACTERISTICS. The data from fig. 6 show that the colonies of *D. artocreas* and *D. faginea* on oatmeal agar at 24°C have a varying rate of growth and a rather different outward appearance. The colony of *D. artocreas* (strain CBS 241.66) has a more retarded growth - on the 12th day after setting the culture it has a diameter of 48.5 mm (average for the 3 repetitions), while that of *D. faginea* (strain CBS 443.67) within the same time period reaches a diameter of 58 mm. Considerable are also the differences in the outward appearance of the colonies of both strains. Twelve days after setting the culture *D. artocreas* forms an indistinctly marked out yellowy-brown colony, having no concentric zonation and no radial rays, secreting a yellow pigment in the nutrient environment around the colony, in the form of a nimbus; the aerial mycelium is sparse, greyish-whity, cotton-like, placed predominantly in the centre; the formation of pycnidia is to be observed not earlier than nine days

after setting the culture. The colony of *D. faginea* is dark-olive-green to almost black, sharply outlined, having a number of concentric rings and well-seen whity radial rays; the aerial mycelium is cobweb-like, grey, predominantly in the centre; no pigmentation of the environment surrounding the colony is to be observed; the formation of pycnidia starts after the 6th day following the setting of the culture.

4. TEMPERATURE REQUIREMENTS. It was experimentally proved that *D. artocreas* and *D. faginea* have different temperature requirements related to their growth and development. At 3°C, on the 12th day after setting the culture *D. faginea* forms a well shaped colony having a diameter of 3.1 mm (average for the 3 repetitions), while *D. artocreas* forms no colony at the same temperature and within the same time period. At 24°C both strains form the largest colonies, their conidiogenesis being most intensive. Considerable differences are to be observed in the requirements of both species towards high temperatures: at 30°C the growth of the colony and the formation of pycnidia of *D. artocreas* are almost normal, while at the same temperature the grows of the colony of *D. faginea* is highly suppressed, no pycnidia forming at that. At 33°C *D. faginea* forms no colony while *D. artocreas* develops successfully even at those relatively high temperatures.

The conclusion that should be drawn out these investigations is, the two species have different temperature requirements: *D. artocreas* develops more successfully at higher temperatures.

One of the goals of the experimental investigations carried out was to establish how and what an extent certain basic factors of the environment (nutrient substratum and temperature) effect the variability of the morphological features, on the base of which our classification scheme of genus *Discosia* is developed. For that purpose, the two strains were cultivated on different nutrient substrata (oatmeal agar, potato-dextrose agar and sterilized lupine stems) at different temperatures after the methods described.

The generalised results show that the position of the conidial appendages and the relative length of the conidial cells remain unchanged, i.e. they are not influenced by the composition of the nutrient environment and the changes in the temperature, while the dimention of the conidia vary within the limits established for each species.

Table 1. Comparison between *D. artocreas* and *D. faginea*.

Species	Dimensions of conidia (µm)
D. artocreas	(16,3-)18±1,2(-20) X (1,8-)2,1±0,2(-2,5)
D. faginea	(13,8-)18±2,7(-23) X (2,5-)2,9±0,2(-3,5)

It ensues from the cited results that the basic morphological features, on which we have founded the intrageneric classification of the fungi from genus *Discosia*, are characterized by insignificant variability amplitudes under changing environmental conditions, due to which their taxonomic value is relatively high.

In fine, the generalized conclusions may be drawn out that *D. faginea* and *D. artocreas* are two separate species having the right to independent existence. The cited conclusion provides us grounds to propound *Discosia artocreas* (Tode) Fr. (basionym *Sphaeria artocreas* Tode) as a type species for genus *Discosia*.

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DISCOSIA SUBRAMANIANII, SP. NOV.

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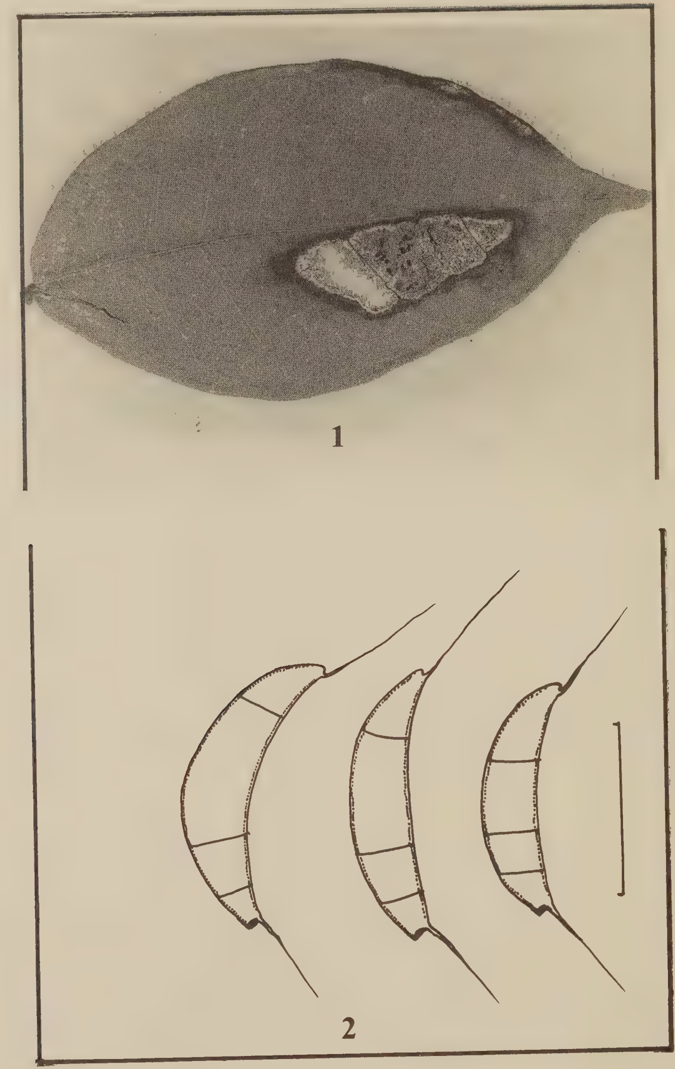
ABSTRACT. *Discosia subramanianii* - a new species of genus *Discosia* Lib. (*Deuteromycotina*, *Coelomycetes*), parasiting on leaves of *Ficus pumila* L. (*Moraceae*) in India is described and illustrated.

During a taxonomic revision of genus *Discosia* Lib. (*Deuteromycotina*, *Coelomycetes*) a herbarium specimen labelled "Discosia artocreas" received from the Herbarium of the International Mycological Institute, Kew, England (IMI) was examined. The fungus is a parasite on leaves of *Ficus pumila* L. (as *F. repens* Rottler) in India. In the present paper a new *Discosia* species, belonging to Section III. *Clypeata* Vanev (Vanev, 1991) is described and illustrated.

DISCOSIA SUBRAMANIANII VANEV, SP. NOV. (Figs. 1, 2)

Maculae magnae (1,5-5 cm in diam.), orbiculares vel angulatae, amphigenae, solitariae, pallido-brunneae, atrobrunneo-marginatae. Conidiomata pycnidialia 175-280 µm in diam., epiphylla, solitaria, sparsa vel gregaria, rotundata, globoso-complanata vel discoidea, nigra, ostiolis 28-63 µm in diam., rotundatis vel plus minusve angularis. Cellulae conidiogenae 8.5-30 X 1.5-2 µm, cylindricae, rectae vel leniter curvatae, hyalinae. Conidia holoblastica (12.5-)14.5±1.21(-17.5) X (2.8-)3.16±0.24(-3.5) µm, fusiformia vel elliptica, apice rotundata, basi truncata, arcuata, rarius recta, dorsiventralia, biappendiculata, hy-



Figs. 1-2. Discosia subramanianii: 1. Leaf spot. 2. Conidia. Scale bar = 10 µm.

alina, 3-septata, semper brevior cellula media, vicina basis, quam cellula media, vicina apicis; appendiculae filiformes, ventrales, hyalinae, proxime apicem basimque conidii formantur.

In foliis vivis Fici pumilae L. (sub Fici repentis Rottler), India, Solan, Martius 1965, G. K. Gupta, IMI No 114375, holotypus, SOM, isotypus (slide).

In speciebus e familia Moraceae Discosia primum observatur.

Leaf spots large (1.5-5 cm in diam.), single, rounded or angular, amphigenous, pale-brown, surrounded by a dark-brown halo. Conidiomata pycnidial, 175-280 µm in diam., ostiolate, epiphyllous, separate, gregarious or scattered, subcircular in outline, depressed-globose or discoid, black; ostioles 28-63 µm in diam., central, circular or irregular, sometimes surrounded by a darker rim. Conidiogenous cells 8.5-30 X 1.5-2 µm, cylindrical, straight or slightly curved, hyaline. Conidia holoblastic (12.5-)14.5±1.21(-17.5) X (2.8-)3.16±0.24(-3.5) µm, mostly fusiform, sometimes ellipsoidal, tappered to the both ends, with a truncate base and an obtuse apex, dorsiventrally curved, hyaline, clearly 3-euseptate, the two middle cells unequal in length: the middle cell adjacent to the apex always longer than the other middle cell, adjacent to the base; conidial appendages two, hair-like, single, unbranched, hyaline, arising just at the apical and the basal extremity of the ventral side of the conidium.

D. subramanianii is the only Discosia species, parasiting on plants of family Moraceae.

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FIRST RECORDS OF JELLY FUNGI (DACRYMYCETACEAE, AURICULARIACEAE, TREMELLACEAE) FROM SONORA, MEXICO

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ABSTRACT

Twelve taxa of jelly fungi growing mainly with **Pinus** and **Quercus** are new records from Sonora, México. They were found in the Municipios of Yécora, Alamos and Nácori Chico. **Tremella fibulifera** and **Dacryopinax yungensis** are reported for the first time from México.

INTRODUCTION

This report is concerned with new records of twelve taxa of jelly fungi from Sonora State, two of them new to México (Table 1). The descriptions are based on material collected by the authors and on several previous publications (Kennedy, 1958; Lowy, 1971; Binyamini, 1983; Bandoni and Oberwinkler, 1983; Courtecuisse and Lowy, 1990). These are common species inhabiting decomposing conifer and oak logs of tropical rain forests throughout the Neotropics (Lowy, 1971). They appear to be confined to the central parts of México (Herrera and Guzmán, 1961), but information about jelly fungi is scarse in the predominantly desertic State of Sonora. The collections in this report were obtained on several field trips during 1990-1991. The source of each record is indicated at the end of each description. All the specimens have been deposited in the National Herbarium of the Instituto de Biología, UNAM (MEXU); the herbarium numbers are indicated in parenthesis.

DACRYMYCETACEAE

Dacrymyces deliquescens (Mérat) Duby, var. **deliquescens**

This species is recognized by its small pulvinate basidiocarps (1 - 4 mm in diam.), yellow color when fresh, drying reddish-brown; hyphae with clamp connections and early 3 - septate basidiospores, 9.5 - 12 x 3 - 5 µm, although these were slightly larger than those described by Kennedy (1958), Lowy (1971) and Pacioni (1981).

HABITAT: On logs and fallen branches of **Quercus** sp.

DISTRIBUTION: Municipio of Yécora: Mesa Grande. Leg. M. Esqueda, M. Coronado. 6.08.1990 (MEXU 22650). Known only from La Marquesa, Mex. (Lowy, 1971) (Table 1).

Dacrymyces dictyosporus Martin Fig. 1.

Basidiocarps yellowish-orange to pale yellow, cerebriform, up 8 -12 mm wide, drying to an inconspicuous, pale yellow horny film, with a root like base; hyphae without clamp connections, from 1.7 - 2 µm; basidia 68 - 75 x 13.6 - 15.3 µm, clavate at first, becoming bifurcate. Basidiospores 21.1 - 26.2 x 11.9 - 15.3 µm broadly ellipsoid, muriform, with 5 - 7 transverse septa and several short longitudinal septa; with a prominent apiculus.

HABITAT: On dry branches of **Pinus** sp.

DISTRIBUTION: It was known from Distrito Federal, Chiapas, Oaxaca, Estado de Mexico, Jalisco, Morelos, Michoacán and Nuevo León (Lowy, 1980) (Table 1), and it is here reported from Municipio of Nácori Chico: Km 45, Nácori Chico to Mesa Tres Ríos road. Leg. M. Coronado, M. Esqueda. 27.05.1990. (MEXU 22649). Municipio of Yécora: Mesa Grande. Leg. M. Coronado, M. Esqueda and E. Pérez-Silva. 15.08.1991. (MEXU 22900).

Dacrymyces palmatus (Schw.) Bres. Figs. 2-3.

Basidiocarps pale yellowish when fresh, gelatinous, lobed, 13 mm long x 3 mm wide, drying to a brown, horny film; contextual hyphae 3.4 µm, with thin walls; some clamp connections; probasidia clavate; becoming bifurcate.Basidiospores 18 - 20 x 5.7 µm with 7 septa, mostly curved, hyaline, with apiculus.

HABITAT: On conifer logs.

DESCRIPTION: It was reported from Distrito Federal, Estado de México, Coahuila, Durango, Morelos, Hidalgo (Lowy, 1980), (Table 1), and it is here reported from Municipio of Nácori Chico: Km 45, Mesa Tres Ríos road. Leg. M. Esqueda, M. Coronado. 14.07.1990 (MEXU 22651).

Dacrymyces punctiformis Neuhoff Fig. 4.

The characteristic feature of this species is its attachment to the substratum by a point, forming small yellow patches, 1-3 mm diam., becoming dark blackish - brown on drying; forming a gelatinous mass on bark when fresh; contextual hyphae with scarse clamp connections, thin walled in lactophenol; metabasidia bifurcate 34 x 1.7 - 2 µm; basidiospores cylindrical, 10 - 15 x 3 - 3.5 µm, 3 septate.

HABITAT: On gymnosperm logs.

DISTRIBUTION: Known only from Estado de México, Chiapas and Hidalgo (Lowy, 1980) from Municipio of Nácori: Km. 14 Nácori Chico to Mesa Tres Ríos road. Leg. M. Esqueda, M. Amaya. 14.07.1990 (MEXU 22653).

Dacryopinax yungensis Lowy Figs. 21, 22.

Basidiocarps stipitate-pileate, yellow when fresh, drying to a horny film; stipe central, 10 - 15 mm tall x 1 - 3 mm diam.; with shorter hairs on abhymenial surface; probasidia subclavate 40 - 45 x 2.5 - 3 µm, metabasidia bifurcate; sterigmata cylindrical. Basidiospores curved-cylindrical, 12.5 x 5 µm, 3 septate.

HABITAT: On dry branches of **Pinus** sp.

DISTRIBUTION: This species was previously known only from Bolivia (Lowy, 1971), and now from Municipio of Yécora: Mesa Grande. Leg. G. Tapia **et al.** 15.08.1991. (MEXU 22901).

AURICULARIACEAE

Auricularia auricula (Hook.) Underwood

Basidiocarps up 5.5 - 8.5 cm x 3 cm wide, auriform, sessil; abhymenium pilose with hairs up to 93 - 100 x 5 µm; hymenium brownish to black on drying; probasidia cylindrical; metabasidia becoming triseptate 56 x 5 µm; hyphae 1.7 µm diam. with clamp connections, interwoven in a gelatinous matrix. Basidiospores curved-cylindrical, 12.6 x 5.1 µm.

HABITAT: Isolated or gregarious, on logs of **Quercus** spp.

DISTRIBUTION: Municipio of Alamos: Arroyo Cuchujaqui-Navojoa road. Leg. G. Yanes. 9.06.1990 (MEXU 22661). Municipio of Yécora Mesa Grande to Santa Rosa road. Leg. M. Esqueda, M. Amaya. 10.07.1990 (MEXU 22662). Municipio of Nácori Chico: Km 45 to Mesa Tres Ríos road. Leg. T. Quintero, M. Esqueda. 14.07.1990 (MEXU 22665).

This species was collected only in the Edo. de México (Lowy, 1965, 1971) where it is common each year, and Chiapas, Distrito Federal, Hidalgo, Jalisco, Morelos (Mendiola and Guzmán, 1973). (Table 1). This species is eaten in the central part of México (Herrera y Guzmán, 1961).

Auricularia delicata (Fries) Henn.

Basidiocarps solitary, orbicular up to 2 cm diam., sessil; abhymenium pilose, brown hairs up 100 x 5 - 6.1 µm with a parenchymatous layer of more or less isodiametrical cells 18 µm; probasidia cylindrical; metabasidia transversaly triseptat, 50-56 x 5 - 7 µm; basidiospores cylindrical to allantoid, 12.6 x 5- 6 µm. Hyphae with clamp connections 2 - 4 µm, interwoven in a gelatinous matrix.

HABITAT: Gregarious on logs of **Quercus** spp.

DISTRIBUTION: Lowy (1971, Courtecuisse and Lowy 1990) recently reported it from French Guiana, but it was not reported from Municipio of Yécora: Yécora to Mesa Grande to Santa Rosa road. Leg. M. Coronado, M. Esqueda. 10.07.1990 (MEXU 22664). Municipio of Nácori Chico, Km 45 Nácori Chico to Mesa Tres Ríos. Leg. M. Esqueda, M. Coronado. 14.07.1990 (MEXU 22666).

This species is more frequent than **A. auricula**. It has been collected several times in Veracruz, México (Lowy, 1965, 1971, 1980). (Table 1). This fungus is eaten in the central part of México.

Auricularia mesenterica Pers.

Basidiocarps gelatinous when fresh, drying coriaceous up to 5 cm wide, sessil; abhymenium pilose, greyish; hymenium with purple tints, smooth to multiveined. Probasidia cylindrical, 56 x 5-8 µm; metabasidia triseptate up 60 µm; sterigmata cylindrical; basidiospores 12.6 x 5 - 5.5. µm, allantoid, germinating by repetition.

HABITAT: Saprobic on wood of broad leaf trees. Gregarious.

DISTRIBUTION: This species is known from Veracruz, Guerrero, Chiapas and Morelos (Lowy, 1971), and Campeche, Colima, Hidalgo, Jalisco, Michoacán, Oaxaca, Puebla (Pérez-Silva **et al.** 1987) it is reported here for the first time from Municipio of Yécora: Yécora Santa Rosa road. Leg. M. Esqueda, M. Coronado. 6.08.1990 (MEXU 22663), (Table 1).

TREMELLACEAE

Tremella fibulifera A. Möller. Figs. 5-7, 18.

Basidiocarps soft gelatinous, pulvinate, lobate, hyaline, white with yellow tints when fresh, up to 2.5 cm in diameter and height; drying, they are reduced to horny effused films. Hyphae 2 - 2.5 µm diam. with clamp connections. Probasidia 10.8 x 10 µm, subspherical to elliptical. Metabasidia cruciate septate, 4-spored. - Fig 5 shows a basidium with well developed sterigmata. Basidio spores 10 x 7.5 µm, elliptical. No hymenial conidia observed. Clamps present at bases of some basidia.

HABITAT: Solitary on logs from **Quercus** sp.

DISTRIBUTION: This species was previously known from Brazil, Colombia, Costa Rica, Panamá (Lowy, 1971; Bandoni and Oberwinkler, 1983) and French Guiana (Courtecuisse and Lowy, 1990) and now from Municipio of Yécora: Yécora. Leg. A. Aparicio. 10.06.1990 (MEXU 22657, 22660). It is reported here for the first time from México.

Tremella fimbriata Fr.: Fr. Figs. 8-10, 19.

Basidiocarps soft gelatinous, light brownish when fresh, imbricate - foliose up to 3 cm broad x 1 cm height, drying to a black film; hyphae 2 - 4 µm wide with clamp connections and bulbous septa. Probasidia subglobose; metabasidia cruciate septate; sterigmata cylindrical up to 2.5 µm wide. Basidiospores subglobose to ovoid, 8 - 10 x 5 - 6 µm, germinating by repetition.

HABITAT: Saprobic, solitary on logs of **Quercus** sp.

DISTRIBUTION: This species was previously known from Colombia, Cuba, Guatemala. In México: Chiapas, San Cristóbal de las Casas (Lowy, 1971), Estado de México (Lowy, 1980), Veracruz (Mendiola y Guzmán, 1973) and French Guiana (Courtecuisse and Lowy, 1990). It is reported here from Municipio of Yécora: Km 11 to Santa Rosa road. Leg. M. Coronado and M. Esqueda. 10.06.1990 (MEXU 22659), (Table 1).

Tremella fuciformis Berk. Figs. 11-13, 20.

This species is recognized by its foliose basidiocarps, with simple lobes whitish - yellow when fresh and drying horny, brownish - yellow 3 - 5 cm x 1 cm height; hyphae with clamp connections and bulbous septa; metabasidia 25 - 30 x 2 - 3 µm wide. Basidiospores ovoid 10 - 12 x 5 - 6 µm, germinating by repetition.

HABITAT: Solitary, on logs of **Quercus** sp.

DISTRIBUTION: Previously known from Argentina, Bolivia, Brazil, Chile, Cuba, Guyana, Jamaica. In. México: Durango, Venezuela (Lowy, 1971); Veracruz (Lowy, 1980) and Distrito Federal (Pérez-Silva **et. al.** 1987); French Guiana (Courtecuisse and Lowy, 1990). It is reported here from Municipio of Yécora: Km 13 Yécora to Santa Rosa road. Leg. A. Aparicio. 10.07.1990 (MEXU 22656), (Table 1).

Tremella lutescens Fr. Figs. 14 - 17.

Basidiocarps cerebriform to lobate, gelatinous, orange - yellow; on drying becoming a film with red tints. Hyphae with clamp connections up to 2.5 µm wide. Probasidia globose; metabasidia cruciate septate; sterigmata 2 - 4 µm wide. Conidia produced on slender conidiophores; basidiospores 5 - 7 x 3.5 - 4.5 µm, germinating by repetition.

This species is found very frequently on branches and trunks of **Quercus** sp.

HABITAT: On decomposing logs of gymnosperm wood in tropical rain forest.

DISTRIBUTION: Previously known from Estado de México (Lowy, 1971), Morelos, Hidalgo, Jalisco and Veracruz (Lowy, 1980); Baja California (Ayala and Guzmán, 1984); Zacatecas (Acosta and Guzmán, 1984). Chiapas, Distrito Federal, Durango. Estado de México (Pérez-Silva **et. al.** 1987), and now from Municipio of Nácori Chico, Km 45 Nácori Chico to Mesa Tres Ríos road. Leg. M. Coronado, M. Esqueda. 14.07.1990, (MEXU 22652). Municipio of Alamos, Km 15 Alamos to Navojoa road. Leg. G. Yanes 29.07.1987 (MEXU 22655), (Table 1).

DISCUSSION

Because of the different ecological conditions prevalent in the Sierra Madre Occidental of Sonora, it is quite probable that in the future the reports on Tremellales of this state will increase. In this paper twelve taxa are registered, two of them, **Tremella fibulifera** and **Dacryopinax yungensis**, are reported for the first time for the Mexican mycobiota.

Until recently, field trips in Sonora have been scarse. In the pertinent literature (Lowy, 1965, 1971; Mendiola y Guzmán, 1963), these two taxa had not been previously reported from México.

Most of the reported taxa in this paper are saprobic - lignicolous on **Pinus** spp. and **Quercus** spp., and their major role in nature is the degradation of lignin and cellulose from stems, bark and debris. The degradation process is indispensable for the maintenance of the carbon balance in nature (Hudson, 1980). Nutrient mobilization into vegetative fungal mycelium is only possible when the complex lignocellulosic medium is degraded (Lu **et al.**, 1988).

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TABLE 1. DISTRIBUTION IN MEXICO OF THE JELLY FUNGI FOUND IN SONORA

	BAJA CALIFORNIA	CAMPECHE	COAHUILA	CHIAPAS	COLIMA	DISTRITO FEDERAL	DURANGO	ESTADO DE MEXICO	GUERRERO	HIDALGO	JALISCO	MICHOACAN	MORELOS	NUEVO LEON	OAXACA	PUEBLA	SAN LUIS POTOSI	SONORA	TABASCO	VERACRUZ	ZACATECAS
AURICULARIA AURICULA				2		6		8		1			2					3*			
A. DELICATA				4						1			1		2		2	2*		10	
A. MESENTERICA		1		1	4				3	3	3	3	8		4	1		1*	1	7	
TREMELLA FIBULIFERA																		** 2			
T. FIMBRIATA				1				2								1		1*		3	
T. FUCIFORMIS						3	1											1*		3	
T. LUTESCENS	1			1		4	1	7		2	1	1	7		2		1	2*		2	1
DACRYMYCES DELIQUESCENS VAR. DELIQUESCENS								2										1*			
D. DICTYOSPORUS				1				4			1	1	3	1	1			2*			
D. PALMATUS			1			1	1	1	1	2			1					1*		1	
D. PUNCTIFORMIS				1				2		1								1*			
DACRYOPINAX YUNGENSIS																		** 1			
TOTAL OF SPECIES	1	1	1	7	1	4	3	7	2	6	3	3	6	1	4	2	2	12	1	6	1

DATA FROM THE BIBLIOGRAPHY. THE NUMBERS INDICATE THE LOCALITIES. * = NEW RECORDS FROM SONORA

** = FIRST RECORD IN THE MEXICAN MYCOBIOTA

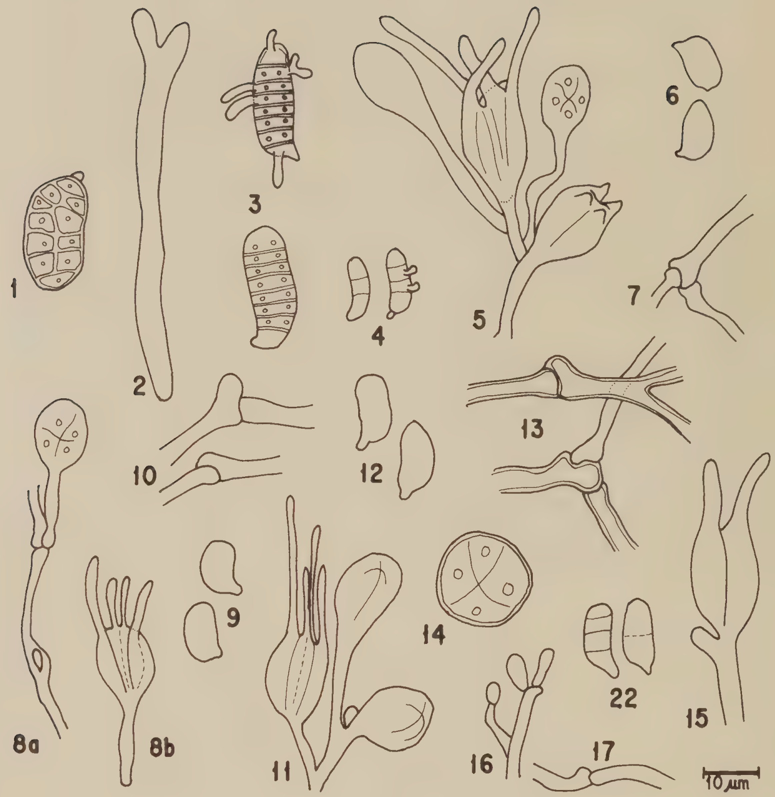
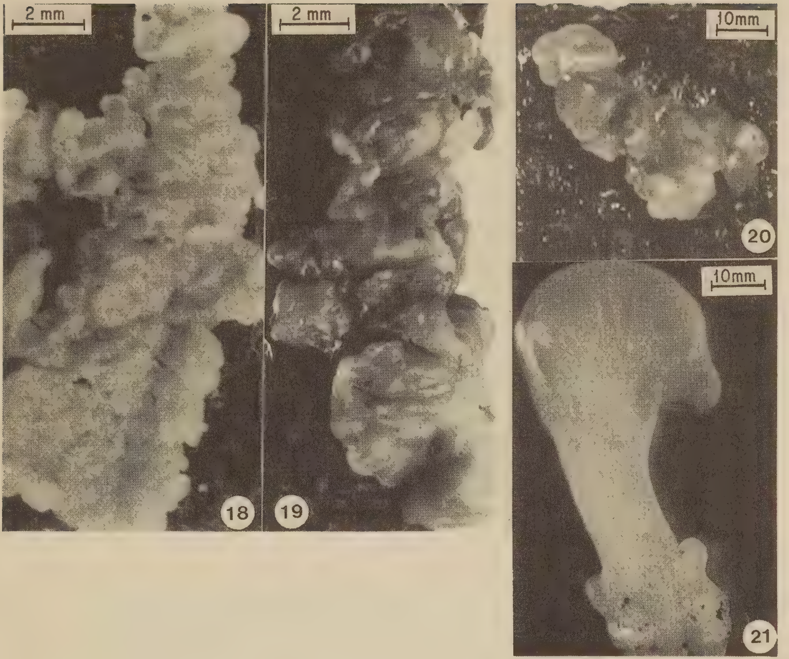


Fig. 1. **Dacrymyces dictyosporus**. 1. Basidiospore. Figs. 2-3 **Dacrymyces palmatus**. 2. Basidium. 3. Basidiospores. Fig. 4. **Dacrymyces punctiformis**. 4. Basidiospores. Figs. 5-7 **Tremella fibulifera**. 5. Section trough basidiocarp lobe showing peripheral hymenium. 6. Basidiospores. 7. Variation in clamp connections. Figs. 8-10 **Tremella fimbriata**. 8a. Probasidium. 8b. Metabasidium. 9. Basidiospores. 10. Clamp connections. Figs. 11-13 **Tremella fuciformis** 11. Section trough basidiocarp lobe showing basidial ontogeny. 12. Basidiospores. 13. Variation in clamp connections. Figs. 14-17. **Tremella lutescens**. 14. Probasidium. 15. Metabasidium. 16. Conidiophore with conidia. 17. Clamp connection. 22. **Dacryopinax yungensis**. Basidiospores: Dibujos F. Villegas.


2 mm
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Figs. 18-21. Habitat of preserved basidiocarps. 18. **Tremella fibulifera.** 19. **Tremella fimbriata.** 20. **Tremella fuciformis.** 21. **Dacryopinax yungensis.**

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ADDITIONAL DATA ABOUT THE GENUS NEPHROMOPSIS (LICHENES, PARMELIACEAE)

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Abstract. A synopsis of the species (16) of the genus Nephromopsis is presented. The new combinations N. endoxanthoides (Awasthi) Randl. et Saag, N. isidioidea (Räsänen) Randl. et Saag, N. komarovii Elenk.) Randl. et Saag and N. yunnanensis (Nyl.) Randl. et Saag are proposed. Information about the lichen substances in all species is provided according to literature as well as the original data obtained by means of thin-layer chromatography.

The lichen genus Nephromopsis was described by Müller Argoviensis (1891) to accommodate N. stracheyi, which was said to have a thallus like in Cetraria but the position of apothecia like in Nephroma. In contemporary lichenology the genus was not usually recognized until in recent times. Räsänen (1952) was the last author to draw several species with nephromoid apothecia on the underside of cetrarioid thallus together into a separate genus under the name Nephromopsis. After a period of almost thirty years the treatment was taken up again by Lai (1980). Meanwhile some of the species had been dealt with under the section Nephromopsis (Müll. Arg.) Rassad. of the genus Cetraria (Rassadina, 1948; Poelt, 1968). Still, the infrageneric systematics of Cetraria has always been poorly developed.

Nowadays homogenous evolutionary lineages are emphasized in the delimitation of genera. Thus the resurrection of the genus Nephromopsis is highly motivated. There are other important characters of this group besides the unusual position of apothecia: presence of laminal pseudocyphellae over the lower surface of the thallus; absence of soredia or isidia; presence of marginal as well as laminal pycnidia, frequently on emergent projections; occurrence of diagnostic medullary compounds (orcinol depsides and depsidones, anthraquinonic pigments and higher aliphatic acids, probably excluding caperatic acid). All the species of this genus are distributed in East and South-East Asia only (including the islands of Japan, Taiwan and Indonesia).

Till now 14 species have been referred as belonging to the recircumscribed genus Nephromopsis. According to the characters mentioned above some more

Cetrariae must be added to the genus*. Below we present a list of all species of *Nephromopsis*, including some new combinations. Information about the chemical compounds in each species is added, as well as a few remarks on morphology.

1. *Nephromopsis asahinae* (Sato) Räsänen, Kuopion Luonnon Ystäväin Yhdistyksen Julkaisuja B 2(6):50, 1952. -- *Cetraria asahinae* Sato. The species is reported to contain fumarprotocetraric and protocetraric acids (Yoshimura, 1979). Usnic acid is an accessory compound in the cortex (Randlane and Saag, 1991) and physodalic acid in the medulla (Lai, 1980). Pseudocyphellae occur over the upper as well as the lower surface.

2. *N. ectocarpisma* (Hue) Gyeln., Ann. Cryptog. Exot.4:173, 1931. -- *N. stracheyi f. ectocarpisma* Hue; *Cetraria nephromoides* (Nyl.) Vainio. Usnic acid in the cortex and some fatty acids in the medulla (lichesterinic, protolichesterinic, nephromopsinic or even caperatic acids have been reported).

3. *N. endocrocea* Asah., Journ. Jap. Bot. 11:24, 1935. -- *Cetraria endocrocea* (Asah.) Sato; *N. endoxantha* sensu Hue (pro parte). The species contains endocrocin and two fatty acids of nephrosteranic and nephrosterinic type (Culberson, 1969; Lai, 1980). Endocrocin is an anthraquinone pigment causing the orange colour of the medulla.

4. *N. endoxanthoides* (Awasthi) Randl. et Saag, comb. nov. Basionym: *Cetraria endoxanthoides* Awasthi, Bull. Bot. Surv. India 24:9, 1982. Fumarprotcetraric and protocetraric acids and traces of lichesterinic and protolichesterinic acids have been demonstrated in this species (Awasthi, 1982). The unidentified pigment, colouring medulla yellowish and causing its K+ yellow reaction, might be secalonic acid. This species is probably closely related to *N. endocrocea*, *N. ornata* and especially *N. asahinae*; *N. endoxanthoides* has pseudocyphellae also over the upper surface similarly to *N. asahinae*.

5. *N. globulans* (Nyl. ex Hue) Lai, Quart. Journ. Taiwan Museum 33:222, 1980. -- *Cetraria globulans* (Nyl. ex Hue) Zahlbr. Lai (1980) reports only the anthraquinonic pigment (secalonic acid C) that colours the medulla yellowish. TLC of the type specimen (China, Yunnan, 1885, Delavay, H-NYL) has also indicated usnic acid in the cortex and lichesterinic and protolichesterinic acids in the medulla.

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* We think that the generic position of *Cetraria kurokawae* Shibuichi et Yoshida and *C. laureri* Kremplh. needs futher studies. Therefore we do not include them into the genus *Nephromopsis* yet, though this was done by Kurokawa (1991). The species without pseudocyphellae over the lower surface (e. g. *Nephromopsis ciliaris* (Ach.) Hue) are included into the genus *Tuckermannopsis* Gyeln. in accordance with Lai (1980) and other recent authors.

6. N. isidioidea (Räsänen) Randl. et Saag, comb. nov. Basionym: Cetraria isidioidea (Räsänen) Awasthi, Bull. Bot. Surv. India 24:10, 1982. Lichesterinic and protolichesterinic acids have been reported by Awasthi (1982). Usnic acid, secalonic acid C and endocrocin have also been tested in the holotype (East Himalayas, Darjeeling district, 1948, D.Awasthi 179, H).

7. N. komarovii (Elenk.) Randl. et Saag, comb. nov. Basionym: Cetraria komarovii Elenk., Bull. Jard. Imp. Bot. St.-Petersbourg 3:51, 1903; C. perstraminea Zahlbr. The species contains usnic acid in the cortex and protolichesterinic and fumarprotocetraric acids in the medulla (Huneck et al., 1984). The latter seems to be an accessory compound in the material from eastern Siberia (17 specimens from TU analysed).

8. N. laxa (Zahlbr.) Sato, Journ. Jap. Bot. 14:783, 1938. -- Cetraria laxa (Zahlbr.) Sato; C. daibuensis Räsänen. Contains also usnic acid in addition to the lichesterinic - protolichesterinic type fatty acids reported by Lai (1980). This is the only species in the genus that bears marginal cilia.

9. N. morrisonicola Lai, Quart. Journ. Taiwan Museum 33:223, 1980. Usnic acid, lichesterinic - protolichesterinic type fatty acids and unidentified pigments have been reported (Lai, 1980) for this species.

10. N. nipponensis (Asah.) Lai, Quart. Journ. Taiwan Museum 33:223, 1980. -- Cetraria nipponensis (Asah.) Culb. Contains protolichesterinic acid as the main substance and physodic and conphysodic acids as accessory compounds (Yoshimura, 1979; Lai, 1980).

11. N. ornata (Müll. Arg.) Hue, Nouv. Arch. Mus. Hist. Nat., 4:90, 1900. -- Cetraria ornata Müll. Arg.; N. delavayi Hue; N. endoxantha sensu Hue (pro parte). Anthraquinonic pigments secalonic acid A (Park, 1990; Randlane and Saag, 1991) or secalonic acid C and the traces of endocrocin (Yosioka et al., 1972) are the substances in the medulla that cause its yellow colour. Fumarprotocetraric and usnic acids appear to be accessory.

12. N. pallescens (Schaer.) Park, Bryologist 93:122, 1990. -- Cetraria pallescens Schaer.; C. citrina Tayl.; C. teysmannii Mont. et Bosch. Contains usnic acid in the cortex and lichesterinic and protolichesterinic acids in the medulla (Yoshimura, 1979; Awasthi, 1982; Park, 1990).

13. N. pseudocomplicata (Asah.) Lai, Quart. Journ. Taiwan Museum 33:224, 1980 -- Cetraria pseudocomplicata Asah. Alectoronic acid is the main compound and α-collatolic and usnic acids are the accessories (Culberson, 1969; Lai, 1980).

14. N. rugosa Asah., Journ. Jap. Bot. 11:12, 1935. -- Cetraria rugosa (Asah.) Sato. Contains usnic acid in the cortex and either physodic or olivetoric acids in the medulla (Yoshimura, 1979; Lai, 1980; Randlane and Saag, 1991). It might be reasonable to describe these chemotypes as separate species.

15. *N. stracheyi* (Church. Bab.) Müll. Arg., Flora 74:374, 1891. -- *Cetraria stracheyi* Church. Bab. This species has apparently also two chemotypes: one with olivetoric (Lai, 1980; Awasthi, 1982) and the other with anziaic acid (Kurokawa, 1967). Usnic acid is an accessory substance. A specimen tested by us (Himalayas, R.Strachey and J.E.Winterbottom, LE) contained olivetoric acid as a major compound and anziaic acid as a minor one plus usnic acid.

16. *N. yunnanensis* (Nyl.) Randl. et Saag, comb. nov. Basionym: *Cetraria yunnanensis* (Nyl.) Zahlbr. Contains usnic acid in the cortex and lichesterinic and protolichesterinic acids in the medulla (one specimen tested: China, Yunnan, 1855, Delavay, H-NYL 36134). Pseudocyphellae occur over both the upper and lower cortex like in *N. asahinae* and *N. endoxanthoides*.

It may be concluded that in the genus *Nephromopsis* usnic acid is an accessory substance in most of the species. Therefore the presence or absence of it has no practical diagnostic value. Fatty acids occur quite frequently (in 11 species out of 16) in the genus. Lichesterinic - protolichesterinic type fatty acids appear to be the major substances in many cases and thus worthy of determination. Orcinol depsides (olivetoric and anziaic acids) and depsidones (alectoronic, α-collatolic, physodic and physodalic acids) are often accessory compounds, and therefore of lower value in the identification of species. Two species (*N. rugosa* and *N. stracheyi*) consist of two chemotypes, which contain either olivetoric or physodic/anziaic acids. The anthraquinone pigments (endocrocin, secalonic acid A and C) represent the most interesting group of chemical constituents in *Nephromopsis*. There are not many cetrarioid lichens that contain them. *N. endocrocea*, *N. globulans*, *N. endoxanthoides*, *N. isidioidea* and *N. ornata* form apparently quite a homogeneous group characterized by yellowish or ochraceous medulla. Still, some further studies of these rare eastern species are needed to make a correct identification key and show the possible derivation patterns inside the genus.

ACKNOWLEDGEMENTS

We wish to express our gratitude to Prof. Teuvo Ahti, University of Helsinki for several helpful suggestions. Prof. Hans Trass, Tartu University is thanked for the general support. We are grateful to the curators in charge of herbaria listed in the text.

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NEW COMBINATIONS OF SOME CETRARIOID LICHENS (PARMELIACEAE)

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Abstract. The following new combinations are proposed on the basis of morphological, anatomical and chemical data: Allocetraria cucullata (Bellardi) Randl. et Saag, A. nivalis (L.) Randl. et Saag and A. potaninii (Oxn.) Randl. et Saag.

The same process that was initiated and successfully carried out by M. E. Hale in the genus Parmelia s. lat. is now proceeding in the large heterogeneous genus Cetraria. Although more than ten new or recently proposed small and homogeneous genera (Allocetraria Kurok. et Lai, Asahinea W. Culb. et C. Culb., Cetrariopsis Kurok., Cetrelia W. Culb. et C. Culb., Cetreliopsis Lai, Esslingeriana Hale et Lai, Masonhalea Kärnefelt, Nephromopsis Müll. Arg., Parmelaria Awasthi, Platismatia W. Culb. et C. Culb., Tuckermannopsis Gyeln.) have been separated from Cetraria, it still includes about five clearly quite different groups of species. One of such groupings is formed by Cetraria cucullata, C. nivalis and C. potaninii. They all are yellow, subfruticose or almost foliose lichens with usnic acid in the cortex. Therefore they do not suit well into the genus Cetraria s. str. represented by the type species C. islandica. Their anatomical structure of the cortex is also totally different from that of the brown fruticose Cetrariae (pachydermatous paraplectenchyma often overlying a thin prosoplectenchymatous tissue of the inner cortex) (Kärnefelt, 1979). When cortical structures in lichens are studied one must bear in mind that the terms "paraplectenchyma" and "prosoplectenchyma" are being used in two different meanings. We accept the terminology by Hale (1976) that determines first of all the hyphal orientation in the cortex and not the form of the lumina. The hyphae in the cortices of C. cucullata, C. nivalis and C. potaninii seem to be oriented anticlinally and thus ought to be considered a palisade plectenchyma. The hyphae are quite short-celled (with frequent septations) and densely conglutinated. In such circumstances the long and cross sections of the cortex are fairly similar in the light microscope to those of the paraplectenchymatous tissue. Still, the palisade plectenchymatous cortex is anticlinally striate in the general appearence and the cells are situated in considerably regular columns. This type of cortex is not very usual in the Parmeliaceae; it is known by now in the parmelioid genus Parmotrema and also in a newly described cetrarioid genus *Allocetraria* (Kurokawa and Lai, 1991). At present the latter includes three very rare species endemic to the Himalayan region (*A. ambigua*, *A. isidiigera* and *A. stracheyi*). Besides this anatomical and general morphological similarity several other common characters can be noticed between the species of *Allocetraria* and the yellow subfruticose *Cetrariae*. *C. cucullata* and *C. nivalis*, although often growing in the suberect or erect form, may have sparse rhizines along the margins or on the lower surface. This has also been mentioned for the species of *Allocetraria* but it is totally lacking in the group of brown *Cetrariae*. All the six named species have tiny pseudocyphellae on the lower surface, either marginal and/or laminal. Cortical as well as medullary chemistry of all these species show remarkable similarity. We cannot agree with Kurokawa and Lai (1991) who considered the chemistry of *Allocetraria* very unique. All of them produce usnic acid in the cortex. Lichesterinic and protolichesterinic acids appear to be the main medullary compounds in this group. Only in two species -- *C. nivalis* and *A. isidiigera* -- the fatty acids have not yet been demonstrated. None of these species contains any depsides or depsidones which are the most widely distributed lichen substances. The presence of anthraquinones (secalonic acid A and related pigments) in *A. isidiigera* and *A. stracheyi* is not quite unusual among the cetrarioid lichens. The same compound has been demonstrated in *Nephromopsis ornata* already (Randlane and Saag, 1991) as well as other closely related anthraquinonic pigments in several species of *Nephromopsis*. Endocrocin, the precursor of secalonic acid (Lai, 1980) together with other red and orange pigments, is also known in the basal part of *C. cucullata* (Krivoshchekova et al., 1982).

On all these considerations we propose to transfer *C. cucullata*, *C. nivalis* and *C. potaninii* into the genus *Allocetraria* Kurok. et Lai.

1.*Allocetraria cucullata* (Bellardi) Randl. et Saag, comb. nov.
Lichen cucullatus Bellardi, Obs. Bot. 1788:54.
Cetraria cucullata Ach., Meth. Lich. 1803:293.

2.*Allocetraria nivalis* (L.) Randl. et Saag, comb. nov.
Lichen nivalis L., Spec. Pl. 1753:1145.
Cetraria nivalis (L.) Ach., Meth. Lich. 1803:294.

3.*Allocetraria potaninii* (Oxn.) Randl. et Saag, comb. nov.
Cetraria potaninii Oxn., Journ. Cycle Bot. l'Acad. Sci. d'Ukraine, 1933:168.

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A NEW SPECIES OF THE LICHEN GENUS PUNCTELIA FROM THE MIDWESTERN UNITED STATES

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Recent field work in the tall grass prairie and savanna provinces of the midwestern United States has revealed the presence of a distinct species of *Punctelia* Krog that is widely distributed and common in portions of the region. The species has been collected rarely because, until recently, relatively little collecting has occurred in this part of the country. The few older specimens which exist were determined as *P. subrudecta* (Nyl.) Krog. Although both taxa have pale lower cortices, lecanoric acid, and soredia, they are very different morphologically and ecologically.

Punctelia missouriensis Wilhelm and Ladd *sp. nov.*
Thallus ut in Punctelia subrudecta (Nyl.) Krog, *sed sorediis grossis granularibus, paucioribus quam decem soredia propria omni soralio; soralia erumpentes pseudocyphellis consociata; cortex plana superne, interdum lobulis clavatis complanatis vel teretiusculus, hi saepe cum soraliis immixis, sed aliquando tegentibus partem amplas corticis superi.*

Thallus foliose, typically 5 cm or more in diameter, the lobes mostly more than 1 mm wide; lower cortex pale to light tan; rhizines white to pale, mostly sparse and diminishing to incipient punctae near the lobe margins; upper cortex sometimes lobulate, gray, lustrous, the margins often brunnescent and weakly reticulate; pseudocyphellae numerous, minutely punctate in the lobe areas, enlarging to 0.2-0.3 mm in diameter and often with 1 or 2 elongate cracks, erupting into into fewer than 10 granular or lobuliform soredia, the soralia remaining discrete or coalescing into masses and sometimes associated with cortical cracks; cortex C-, K+ yellow (atranorin); medulla and soredia C+ red, K- (lecanoric acid). Apothecia very rare; microconidia not seen.

Type collection: MISSOURI. **Crawford Co.**, Onondaga Cave State Park, Vilander Bluff, on *Juniperus virginiana*; NW¼ NW¼ Sec.15 T39N R2W; Ladd & Wilhelm 15879, 22 DEC 1991 (Holotype: MOR; Isotypes: COLO, BAFC, F, IMI, LSU, MICH, NY, O, OMA, US).

Punctelia missouriensis is distinguished from *P. subrudecta* by its coarser, more granular to often lobuliform, sometimes partly corticate soredia occurring in small clusters of 10 or fewer per soralium; these soralia are almost always associated with pseudocyphellae or cracks in the upper cortex. *Punctelia subrudecta* has farinose to finely granulose soredia occurring in large numbers in each soralium; the soralia are often diffusely laminal and marginal as well as emanating from the pseudocyphellae, and the soralia average larger than in *P. missouriensis*. Additionally, *P. missouriensis* often has flattened, corticate lobules; these are absent in *P. subrudecta*. Plates I - III illustrate the differences between these taxa.

Two other diasporous taxa of *Punctelia* occur in the Midwest. *Punctelia rudecta* (Ach.) Krog is characterized by fine, cylindrical isidia, these often with darkening tips and sometimes branched. *P. perreticulata* (Räs.) Wilhelm & Ladd is a usually smaller lichen with a foveolate-ridged upper cortex and finely farinose marginal and laminal soredia.

Riefner (1989) has recently reported *Punctelia punctilla* (Hale) Krog from southern California. This is a smaller-lobed, coarsely isidiate species superficially similar to *P. missouriensis*. The cortical pseudocyphellae of *P. punctilla*, although sometimes appearing insipiently erumpent, do not develop into aggregated groups of well-defined soredia. *P. punctilla* is characterized by cylindrical to somewhat flattened, darkly apiculate isidia, as contrasted with the flattened, sorediose lobules sometimes occuring in *P. missouriensis*. The isidia in *P. punctilla* are frequently coralloid-branched; in *P. missouriensis* the lobules are infrequently simply-branched.

In her key to the genus, Krog (1982) implied that *P. bolliana* is consistently lobulate with isidioid to squamiform lobules, apparently on the basis of Mueller's (1877) type description of the species, which mentioned lobules. The vast majority of Midwestern collections of this taxon we have examined are without lobules. In rare specimens with a few lobulate processes, these are foliose and clearly not confuseable with isidia.

While the diaspores of *P. missouriensis* are not typical soredia as seen in *P. subrudecta*, they certainly represent medullar eruptions in the cortex which coalesce into discrete soralia. The diaspores of *P. punctilla* are clearly isidiate, and more closely related to those of *P. rudecta*. A revised key to North American *Punctelia* is included below.

An apparent analogue of *P. missouriensis* occurs in South America [*i.e.* Montes 12038G, Paraguay (NY)]. This evidently undescribed lichen has nearly identical diaspores, but a black lower cortex and contains gyrophoric acid. It has previously been confused with *P. constantimontium* Sérusiaux, a species with abundant lobuliform squamules. Conidiospores in *P. constantimontium* are uncinate and about 5-7 μ long, while in the analogue of *P. missouriensis*, the conidia are filiform and about 10-12 μ long. We have been unable to locate pycnidia on any specimens of *P. missouriensis*. Krog (1982) mentioned that the prevailing conidial morphology in the genus is unciform.

In North America, *Punctelia missouriensis* appears to be a common component of the lichen flora of the Tallgrass Prairie/Interior Highlands savanna biomes. It occurs regularly on exposed older trunks of oaks and other trees in areas of former prairie and open savanna vegetation, even when most of the ambient landscape has been converted to agriculture. It is largely absent from the more closed timbers currently existing in much of the Midwest, except that it occurs with some regularity on lightly shaded siliceous rock faces in the unglaciated districts. It occurs regularly where anthropogenic activity has rendered the landscape more open, such as in parks, along roadsides, and in cleared agricultural areas. About half of the nearly 200 specimens we have seen were collected on a species of *Quercus*, about 75% of which were in the section Erythrobalanus. About 10% of the specimens are from *Juniperus* and another 10% are saxicolous. The 169 known corticolous specimens occurred on 43 different tree species. We have also seen a specimen from the interior temperate region of Argentina, although no effort has been made to examine South American material.

It would appear that the center of distribution of this species is in the Interior Highlands region in North America. Significant portions of this region remain unexplored by lichenologists. Based upon our field observations, additional localities for *P. missouriensis* certainly occur in the largely unexplored region between the Mississippi River and the Appalachian Mountains. *Punctelia missouriensis* is common in the lower Midwest, especially through Missouri, northern Arkansas, southern Illinois and Indiana, western Kentucky, and Tennessee. It is known from 10 states, with approximately equal distribution in glaciated and unglaciated regions (Figure 1).

In the Interior Highlands, *P. missouriensis* occurs most commonly in high-quality natural areas, including savannas, glade margins, and bluff systems. In this region, it regularly occurs on saxicolous substrates as well as on trees. Elsewhere in its range, it occurs in remnant savannas and prairie border timbers, and in anthropogenically altered sites where older trees remain. In this latter habitat, *P. rudecta,* and often *P. bolliana,* are consistent associates.

Punctelia subrudecta, on the other hand, is a widely distributed lichen evidently tolerant of more closed woodlands. In the regions where its range overlaps *P. missouriensis,* it is restricted to remnant sites of fairly high natural quality. Typical substrates there include *Juniperus virginiana* and *Quercus alba,* as well as *Pinus echinata* and several other deciduous tree species. Judging from existing herbarium records, *P. subrudecta* is more common in eastern, northern, and western North America, where it occurs on a wide variety of corticolous substrates as well as on rocks. It is absent from the Tall Grass Prairie districts of the central United States. We have also seen specimens from Central America, Europe and Africa. In those areas where it is a consociate of *Punctelia missouriensis, P. subrudecta* is not as tolerant of agricultural activity or woodland clearing.

It is interesting to speculate whether *P. missouriensis* has spread recently with the advent of a plethora of anthropogenically created corticolous habitats, such as parks, pastures, landscaped areas, fencerows and farm borders. With perturbations to the landscape wrought by European settlement, a more or less continuous "bridge" of corticolous substrates has developed across the region while the presettlement timbers of the area, where they still exist, have become more closed-canopied as a result of fire suppression, and at the same time fragmented and interspersed with cleared areas. These conditions might have allowed an eastward spread of *P. missouriensis;* the Kentucky, Tennessee, and Alabama populations are all from widely spaced trees in anthropogenically altered landscapes. Many of the host trees in the glaciated, silt-loam districts of the prairie biome are also in artificial landscapes.

Key to the North American Species of *Punctelia*

- Thallus without diaspores, though sometimes lobulate.
  - Lower surface black or darkening.
    - Medulla C-, fatty acids only; eastern . . . . *P. appalachensis*
    - Medulla C+ rose, gyrophoric acid; Texas . . . . *P. subpraesignis*
  - Lower surface pale to light tan.
    - Medulla C-, fatty acids only; almost always corticolous . . . . *P. bolliana*
    - Medulla C+ red, lecanoric acid; corticolous or saxicolous.
      - Microconidia (8)10-14μ; southwestern . . . . *P. hypoleucites*
      - Microconidia 4-8μ; widespread . . . . *P. semansiana*
- Thallus isidiate or sorediate, lobulate or not.
  - Lower surface prevailingly dark to black; medulla C- or C+ rose (gyrophoric acid).
    - Medulla C-, fatty acids only; pseudocyphellae large and easily distinguished as pore-like openings; soredia coarse and subisidiate . . . . *P. reddenda*
    - Medulla C+ rose; pseudocyphellae small, appearing as tiny white dots; soredia farinose.
      - Thallus brown and lustrous, on exposed rocks at high altitudes or along shorelines . . . . *P. stictica*
      - Thallus mineral gray, not notably lustrous; prevailingly corticolous; eastern . . . . *P. borreri*
  - Lower surface pale to light tan; medulla C+ red (lecanoric acid).
    - Thallus with simple to coralloid isidia.
      - Isidia fine and cylindrical, generally with a shiny well-developed cortex; widespread on a variety of substrates . . . . *P. rudecta*
      - Isidia papilliform, dull, with a poorly developed cortex; saxicolous in southern California . . . . *P. punctilla*
    - Thallus sorediate, sometimes with lobules.
      - Soredia mostly fewer than 10 per soralium, coarsely pustular to lobulate, the soralia often appearing as eruptions from the pseudocyphellae . . . . *P. missouriensis*
      - Soredia farinose to finely granular, in well-developed marginal and laminal soralia; soredia numerous.
        - Upper cortex foveolate-ridged; lobes rarely more than 2 mm wide . . . . *P. perreticulata*
        - Upper cortex smooth or weakly reticulate; lobes typically more than 2 mm wide . . . . *P. subrudecta*

Representative Specimens

All specimens are deposited at the Morton Arboretum, Lisle, Illinois (MOR) unless indicated. Only one specimen is cited from each county.

ARGENTINA: CORDOBA. **San Alberto:** *sobre espinillos*, Estrabou 45037 (COLO).

UNITED STATES: ALABAMA. **Limestone:** on oak, Ladd 14435.

ARKANSAS. **Benton:** on *Quercus velutina*, Ladd 14632; **Carroll:** on *Juniperus ashei*, Ladd 14723; **Clay:** on *Quercus rubra*, Ladd 16109; **Greene:** on *Carya,* Ladd 15959; **Lee:** on *Fagus grandifolia*, Ladd 15693; **Madison:** on shaded, cherty limestone, Ladd 14785; **Monroe:** on *Quercus stellata*, Ladd 15669; **Montgomery:** Hale 6 (ILL); **Pike:** on shaded rock, Ladd 14960; **Prairie:** on *Quercus rubra*, Ladd 14868; **Stone:** on *Quercus falcata,* Ladd 15498.

ILLINOIS. **Carroll:** on *Quercus*, Jones 2679 & 2695; **Edgar:** on *Quercus rubra*, Wilhelm & Wetstein 17998; **Effingham:** on *Quercus velutina*, Wilhelm & Ladd 16453; **Fayette:** on *Quercus velutina*, Wilhelm & Wetstein 17077; **Gallatin:** on dry sandstone wall, Parker 2327; **Hardin:** on *Juglans nigra*, Wilhelm 16834; **Jackson:** on *Quercus*, Wilhelm 8300; **Jo Daviess:** on *Gleditsia triacanthos*, Wilhelm & Wetstein 19972; **Johnson:** on *Juniperus virginiana*, Wilhelm & Wetstein 19041; **Lee:** on *Quercus rubra*, Jones 1193a; **McLean:** on *Ostrya virginiana*, Wilhelm 16409; **Massac:** on *Quercus velutina*, Wilhelm & Wetstein 18784; **Piatt:** on *Quercus velutina*, Wilhelm & Wetstein 18020; **Rock Island:** on *Quercus macrocarpa*, Jones 1528; **Saline:** on *Juniperus virginiana*, Wilhelm & Johnson 16553; **Stephenson:** on fallen branch, Jones 1336; **Union:** on sandstone, Winterringer 1832 (ILL); **Wabash:** on *Quercus rubra*, Wilhelm & Wetstein 18157; **Warren:** on planted *Quercus palustris*, Wilhelm & Wetstein 19667; **Williamson:** on *Quercus rubra*, Wilhelm & Wetstein 19163.

INDIANA. **Bartholomew:** on *Fagus grandifolia*, Wilhelm 20063; **Gibson:** on *Acer saccharinum*, Wilhelm 20114; **Jasper:** on *Quercus velutina*, Wilhelm 14174; **Knox:** on *Quercus palustris*, Wilhelm 20115; **Montgomery:** on *Quercus alba*, Wilhelm *et al.* 18678; **Newton:** on *Quercus velutina*, Wilhelm 13254; **Sullivan:** on *Platanus occidentalis*, Wilhelm 20120; **Vanderburgh:** on *Quercus velutina*, Wilhelm 20113.

IOWA. **Clayton:** on *Pinus strobus*, Imshaug 28050 (MICH, MSC).

KANSAS. **Cherokee:** on *Quercus marilandica*, Ladd & Heuman 15563.

KENTUCKY. **Butler:** on *Ulmus alata*, Wilhelm 20108; **Daviess:** on *Quercus falcata, Wilhelm 20110*; **Franklin:** on *Malus pumila*, Ladd 11460; **Hardin:** on *Diospyros virginiana*, Wilhelm 20064; **Hart:** on *Quercus imbricaria*, Wilhelm 20067; **Henderson:** on *Quercus palustris*, Wilhelm 20112; **Ohio:** on *Quercus velutina*, Wilhelm 20109; **Simpson:** on *Carya ovata*, Wilhelm 20105; **Warren:** on *Quercus falcata*, Wilhelm 20068.

MICHIGAN. **Berrien:** on *Quercus velutina*, Wilhelm & Wetstein 19276.

MISSOURI. **Andrew:** on *Quercus macrocarpa*, Ladd 11264; **Audrain:** on *Quercus velutina*, Ladd & Wilhelm 9924; **Barry:** on *Juniperus*, Egan 12880 (Egan Herbarium); **Benton:** on shaded chert boulder, Ladd 9041; **Bollinger:** on *Quercus velutina*, Wilhelm & Ladd 11061; **Boone:** on *Gleditsia triacanthos*, Berry 219 (UMC); **Buchanan:** on *Quercus rubra*, Ladd 12296; **Butler:** on *Taxodium distichum*, Ladd 14183; **Callaway:** on *Quercus marilandica*, Ladd 11162; **Camden:** on *Cercis canadensis*, Ladd 15609; **Cape Girardeau:** on *Quercus velutina*, Skinner 846; **Carroll:** on *Quercus macrocarpa*, Ladd 8328; **Cedar:** on *Carya*, Ladd & Ladd 7830; **Clinton:** on *Quercus alba*, Ladd 15210; **Cole:** on *Fraxinus americana* Ladd 11992; **Cooper:** on *Celtis laevigata*, Ladd 10841; **Dade:** on *Quercus velutina*, Ladd 14860; **Dallas:** on *Prunus*, Ladd & Wilhelm 7424; **Daviess:** on *Acer* *saccharum*, Ladd 11231; **DeKalb:** on *Gleditsia triacanthos*, Ladd 11278; **Douglas:** on shaded sandstone ledge, Wilhelm 10870; **Dunklin:** on *Quercus stellata*, Summers 3153; **Gasconade:** on shaded sandstone boulder, Ladd 12646; **Greene:** on *Quercus marilandica*, Ladd & Ladd 8484; **Grundy:** on *Quercus palustris*, Ladd 15211; **Henry:** on fallen tree trunk, Ladd 13909; **Hickory:** on cherty sandstone boulder, Ladd & Ladd 7675; **Holt:** on *Quercus velutina*, Wilhelm & Wilhelm 15943; **Howell:** on *Quercus stellata*, Wilhelm 10981; **Iron:** on shaded rhyolite face, Ladd 14431; **Jasper:** on *Ulmus rubra*, Ladd 9340; **Jefferson:** on *Quercus velutina*, Wilhelm 11215; **Laclede:** on *Juniperus virginiana*, Ladd 10154; **Lafayette:** on rotting stump, Ladd 11493; **Lawrence:** on *Quercus stellata*, Ladd 10490; **Lewis:** on *Prunus serotina*, Ladd 14842; **Lincoln:** on *Fraxinus americana*, Ladd 15156; **Livingston:** on *Quercus macrocarpa*, Ladd 11057; **McDonald:** on *Ulmus alata*, Ladd 9241; **Macon:** on *Quercus velutina*, Wilhelm & Ladd 12354; **Madison:** on shaded red granite, Ladd & Schuette 12955; **Maries:** on *Quercus velutina*, Ladd 12597; **Marion:** on *Gleditsia triacanthos*, Ladd 10431; **Mercer:** on *Tilia americana*, Ladd 11288; **Mississippi:** on *Celtis*, Wilhelm 13377; **Moniteau:** on *Acer saccharinum*, Wilhelm & Ladd 15739; **Monroe:** on *Quercus rubra*, Ladd & Wilhelm 9851; **Montgomery:** on *Bumelia lanuginosa*, Ladd 13660; **Morgan:** on *Quercus imbricaria*, Ladd 10030; **New Madrid:** on *Quercus*, Wilhelm 11967; **Newton:** on *Quercus palustris*, Ladd 9285; **Nodaway:** on *Quercus velutina*, Wilhelm & Wilhelm 15919; **Osage:** on shaded sandstone, Ladd & Wilhelm 12514; **Ozark:** on *Carya*, Ladd & Wilhelm 7500; **Pemiscot:** on *Liquidambar styraciflua*, Ladd 10169; **Pettis:** on *Quercus alba*, Wilhelm 15209; **Phelps:** on mossy shaded sandstone wall, Ladd 12990; **Pike:** on *Quercus velutina*, Schuette 325; **Platte:** on *Quercus velutina* and *Q. alba*, Wilhelm & Wilhelm 15931; **Polk:** on *Quercus marilandica*, Ladd 10784; **Pulaski:** on *Juniperus virginiana*, Ladd 12573; **Ralls:** on *Juniperus virginiana*, Schuette 916; **Randolph:** on *Quercus velutina*, Wilhelm & Ladd 12373; **Reynolds:** on *Quercus velutina*, Ladd 11094; **St. Clair:** on exposed sandstone, Ladd & Ladd 6461; **St. Francois:** on *Quercus rubra*, Ladd & Summers 12089; **Ste. Genevieve:** on shaded sandstone wall, Ladd 10557; **St. Louis:** on *Carya*, Wilhelm 10716; **Scott:** on *Prunus serotina*, Wilhelm 10463; **Shannon:** on *Pinus echinata*, Ladd *et al.* 8671; **Shelby:** on *Juniperus virginiana*, Ladd & Wilhelm 9814; **Stoddard:** on *Quercus palustris*, Ladd & Wilhelm 7605; **Stone:** on *Quercus marilandica*, Ladd & Wilhelm 12362; **Sullivan:** on *Quercus palustris*, Ladd 11025; **Taney:** on *Juniperus virginiana*, Ladd & Ladd 9405; **Texas:** on *Juniperus virginiana*, Ladd 9222; **Vernon:** on shaded sandstone wall, Ladd 13142; **Warren:** on chert boulder, Ladd 10615; **Washington:** on *Juniperus virginiana*, Ladd 9788; **Webster:** on *Quercus velutina*, Ladd 6518; **Wright:** on *Ulmus alata*, Ladd 15016.

TENNESSEE. **Dickson:** on *Quercus rubra*, Ladd 14866; **Dyer:** on *Quercus lyrata*, Ladd 10181; **Giles:** on *Liquidambar styraciflua*, Wilhelm 20094; **Madison:** on *Quercus*, Ladd 14867; **Marshall:** on *Quercus alba*, Wilhelm 20098; **Maury:** on *Quercus velutina*, Wilhelm 20100; **Montgomery:** on *Quercus rubra*, Ladd 14862; **Robertson:** on *Acer rubrum*, Wilhelm 20069.

Acknowledgments

Appreciation is expressed to Richard Harris of the New York Botanical Garden for his review and comment; Webster Crowley of the Morton Arboretum and Marty Cano and Linda Johnson of the University of Nebraska Medical Center for electron microscopy, and Robert Egan of the University of Nebraska at Omaha for electron

microscopy and reveiw and comment. Sherry Pittam of the Smithsonian Institution and Tim Hogan of the University of Colorado provided herbarium material.

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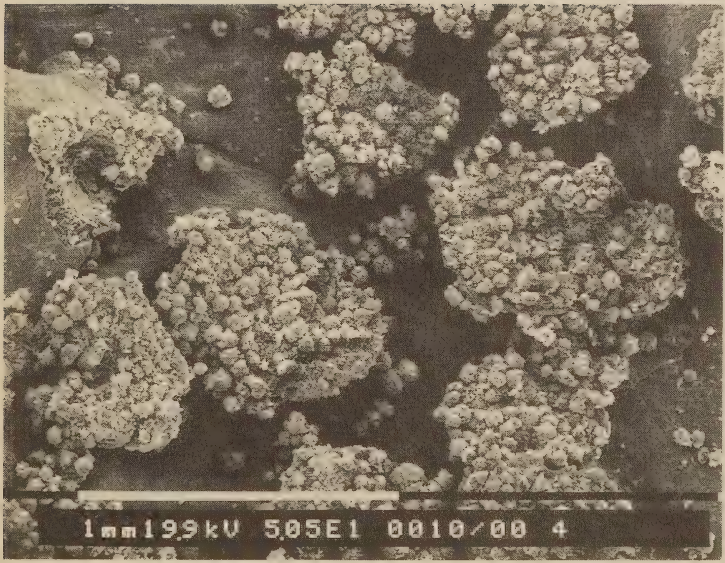

PLATE I. *Punctelia subrudecta* [Ladd 14413, Missouri], 50X.

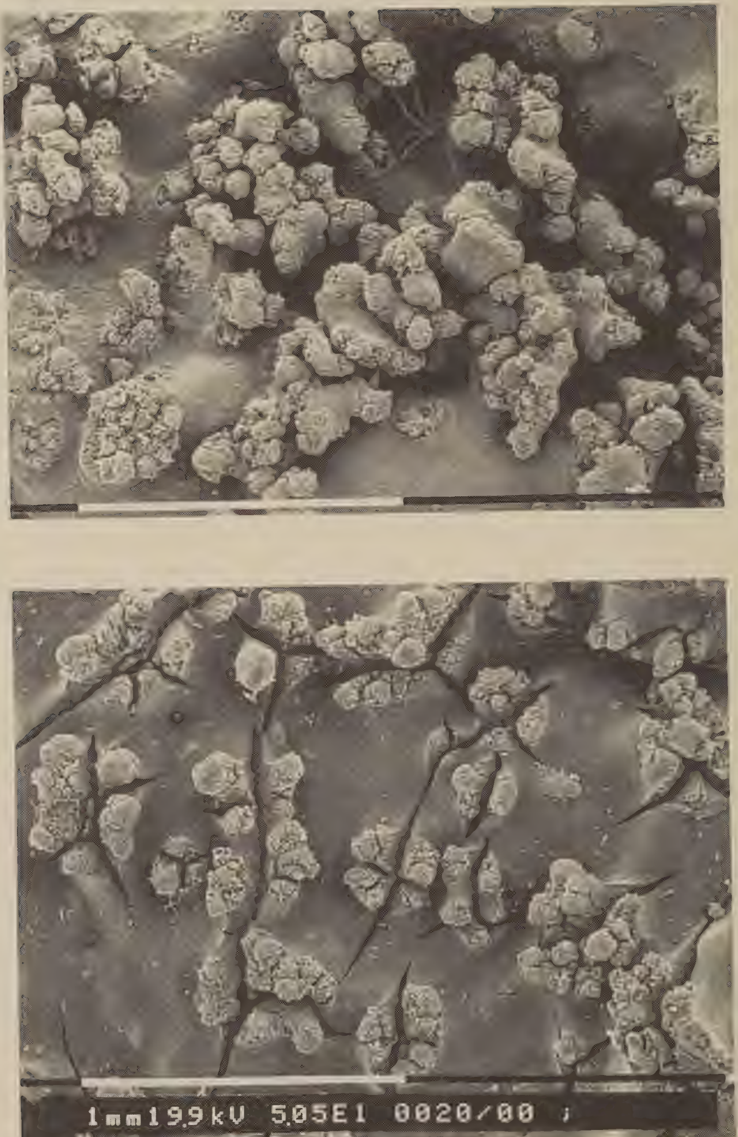

PLATE II. Top: *Punctelia missouriensis* [Ladd 14189, Missouri], 50X; note lobules, some of which are sorediate. Bottom: *P. missouriensis* [Ladd 14652, Arkansas], 50X; note soredia associated with cracks in upper cortex.

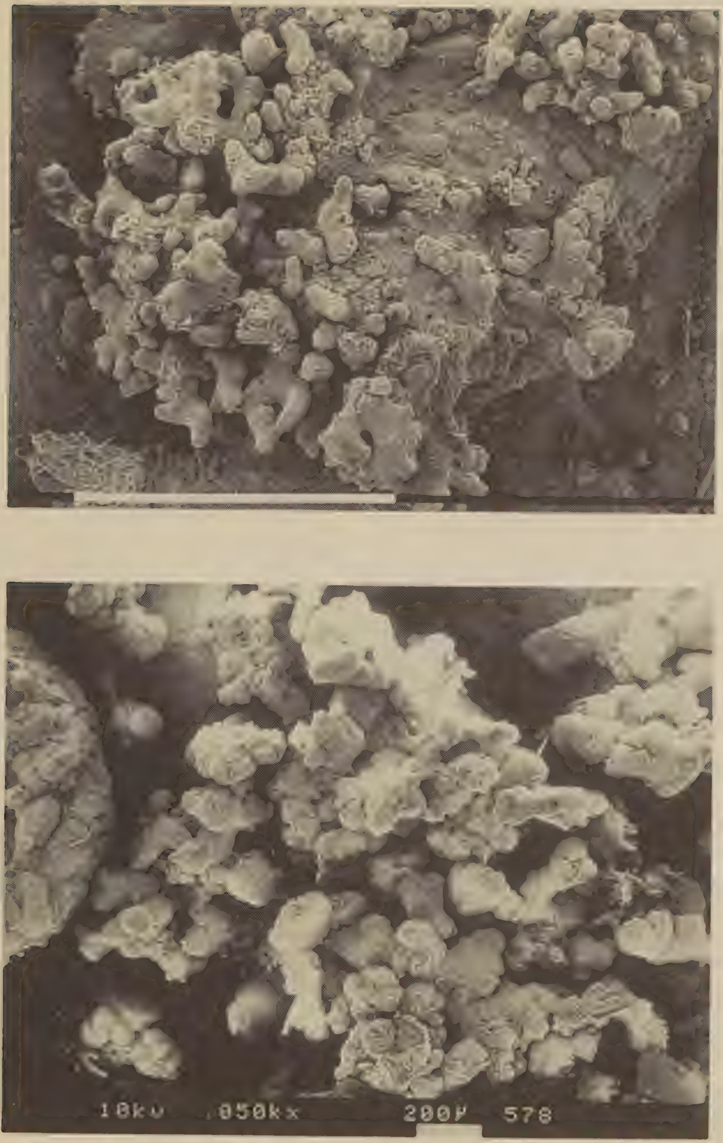
10kV
.050kx
200P
578

PLATE III. Top: *Punctelia rudecta* [Ladd 11169, Missouri], 50X. Bottom: *P. punctilla* [Almborn 8941, South Africa, Isotype (US)], 50X.

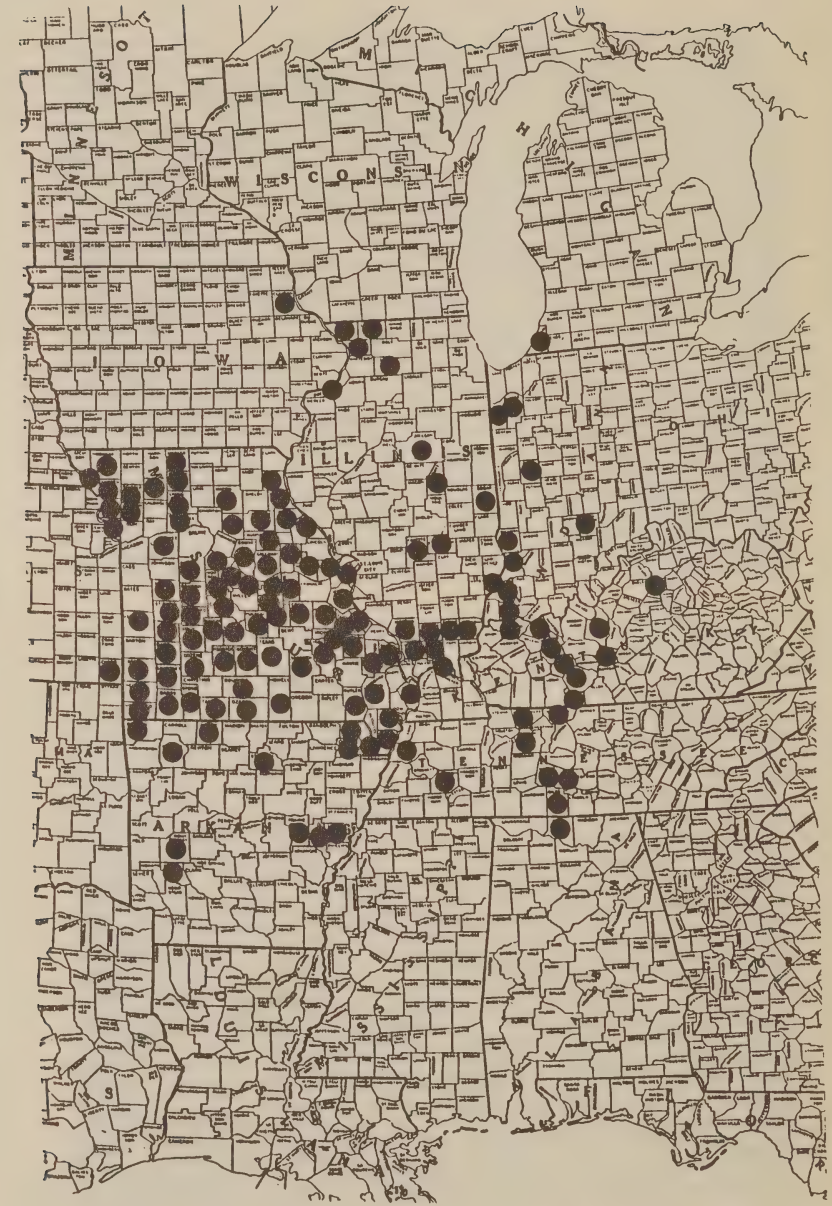
WISCONSIN
IOWA
ILLINOIS
MICHIGAN
ARKANSAS

Figure 1. Range map of *Punctelia missouriensis* in North America.

MYCOTAXON

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BOOK REVIEWS

L. M. Kohn, Book Review Editor

Ascomyceten im Bild, by I. and H. Schmid. 1 Serie, Tafel 1-50, 16 (unnumbered) pp., 50 pl. in ring binder 20x22 cm, 1990. DM 88.-- US$55.-- 2 Serie, Tafel 51-100, 18 (unnumbered) pp., 50 pl., 15x21 cm, looseleaf for inclusion in binder provided with Serie 1, 1991. DM 86.-- US$53.75. IHW-Verlag, Bert-Brecht-Str. 18, D-8057 Eching, Germany. ISBN 25481072

Elegant, often gorgeous, colored photographs (two of each fungus illustrated, on opposite sides of each looseleaf sheet) are accompanied by clear macroscopic, microscopic, and ecological notes (students would be advised to brush up on their German), and by line drawings of important microscopic characters. Scales of magnification are clearly indicated, but the individual illustrations are not sub-numbered, a minor inconvenience in citing these figures.

Illustrated in these two series are 13 members of the Pezizales, 35 of Helotiales, 5 of Rhytismatales, 4 of Clavicipitales, 9 of Hypocreales, 1 of Polystigmatales, 2 of Ophiostomatales, 4 of Sordariales, 3 of Sphaeriales, 2 of Diaporthales, 1 of Elaphomycetales, 1 of Erysiphales, 1 of Gymnoascales, and 19 of Dothideales. Each fungus is assigned to a currently used family in an overview table provided at the beginning of each series. A sheet of important synonyms for the illustrated species is provided for each series, a literature listing for the citations on each plate is provided for each series, and indices to the species names (Gattungsindex) and to the species epithets (Artenindex) are provided for series I, with those indices being cumulative for both fascicles in series II.

This reviewer can scarcely wait for additional series to be published, and was pleased to see illustrated many Discomycetes (but also other Ascomycetes) that are relatively uncommon, and not well-illustrated elsewhere. That alone makes these plates essential to any library hoping to be comprehensive. In addition, the authors have a good grasp of modern taxonomy, and I find little to fault in their choice of names or their nomenclature. Typographical errors are very few. These plates are a delight to own. The quality is equivalent to that of Breitenbach and Kränzlin's *Fungi of Switzerland*, which is to say of a very high standard indeed. The format here allows for larger photographs, two for each species. And as in that book, the full collection data and place of deposit of the specimen for the illustrated material is provided. Bravo! *Richard P. Korf, Plant Pathology Herbarium, Cornell University, Ithaca, New York, USA.*

Russula-Monographie Romagnesis [,] Zum Studium von Täublingen unentbehriche Schlüssel und Tablellen aus der Russula-Monographie Romagnesis unter Berücksichtigung der Ergänzungen Romagnesis von 1985 und 1987. Paper, 66 pp. IHW-Verlag, Bert-Brecht-Str. 18, D-8057 Eching, Germany. DM 32.-- US$20.--

This booklet is intended for those who would find useful a German translation of the infrageneric descriptions and species keys from Henri Romagnesi's magnum opus, LES RUSSULES D'EUROPE ET D'AFRIQUE DU NORD (Éditions Bordas, Paris, 1967), as revised to include additional species and taxonomic and nomenclatural changes published later by Romagnesi. Also, descriptions of eight alpine species of Russula treated by Rober Kühner in 1975 are appended. The booklet illustrates neither fruit-bodies nor microscopic structures such as spores and pileus cuticular elements, whose characters are essential in identifying russulas but difficult to convey in words. In partial compensation for this the translator provides Romagnesi's keys to spore ornamentational units and patterns, which may help somewhat. Spore color is another significant taxonomic character in Russula, and a plate meant to reprduce Romagnesi's ten spore-color samples is also included. Unfortunately, in the review copy of the booklet "mittlecreme", "intensiv creme", and "blass ocker" are indistinguishable, as are "intensiv ocker" and "blass gelb"; only four of the samples are identical or reasonably close to their normal equivalents in my copy of Romagnesi's book itself. All things considered, I doubt that the booklet will give much satisfaction to someone struggling to identify a russula. *Robert L. Shaffer, University of Michigan Herbarium, Ann Arbor, Michigan, USA.*

Lichens Selecti Exsiccati Upsalienses. Fascicle 4, by R. Moberg. Thunbergia No. 14. Paper, 12 pp., 1991. Distributed by the Botanical Museum, Uppsala University. ISSN-0283-2275. Skr. 30.-- + postage [ca. US$6.--].

This publication documents with complete data the specimens distributed in the fourth fascicle of an exsiccati now containing 100 numbers and material from 17 countries. This fascicle includes 26 specimens, representing 25 taxa distributed in 21 genera, of which two are isotypes and one is from near the type locality. Most numbers are from Sweden but 9 are extra-limital collections. Critical comments are provided for several taxa. An alphabetical listing of the taxa included in the first 100 numbers is included of which 10 are types and 2 represent new combinations. Although of limited general usefulness, most herbaria with lichenological holdings will want to have a copy. *J. C. Krug, Dept. of Botany, University of Toronto, Canada.*

An Annotated List of Peronospora Names, by O. Constantinescu. Thunbergia No. 15. Paper, 110 pp., 1991. Distributed by the Botanical Museum, Uppsala University. ISSN-0283-2275. Skr. 110.-- + postage [ca. US$20.--]

This list includes 787 specific and subspecific names referred to Peronospora with 653 correctly placed in the genus of which 551 are valid and legitimate. Among the excluded names, 88 belong to other genera of the Peronosporales. Two new combinations are proposed. As the author indicates, the practice of considering one host to be infected by one species has resulted in a large number of uncritically described and sometimes invalid taxa. Each entry includes author, bibliographical citation, host, original locality, location of authentic specimens, and in some instances comments on taxonomic position. A simple coding, explained in the introduction, is used for the location of the specimen, nomenclatural status and taxonomic correctness. In most instances location of the original speciment and reference has been checked. On account of the large number of taxa little attempt is made to typify names but rather the compilation is restricted to bringing together and clarifying the information on taxa described in Peronospora. Only 36 taxa are typified based on examination of material and comparison with the protologue. A host-fungus index of all valid and invalid names is included. Since no modern treatment exists, this is an important compilation that will be essential for anyone dealing with this group of fungi. *J. C. Krug, Dept. of Botany, University of Toronto, Canada.*

The Genus Clavariadelphus in North America, by Andrew S. Methven. Bibliotheca Mycologia Band 138. Softcover, 143x233 mm, 192 pp., 1990. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Johannesstr. 3 A, D-7000 Stuttgart 1, Germany. (U.S. Agent: Lubrecht & Cramer, R.D. 1, Box 244, Forestburgh, NY 12777) ISBN 3-443-59039-X. DM 80.-- US$62.50

This monograph on Clavariadelphus constitutes an intensive study of the genus in North America, and a preliminary study of the genus worldwide. In this work new species are described, new characteristics are used, and the genus is redefined. While most of the work consists of keys and descriptions to 24 species or varieties, this information is augmented with tables of spore or chemical data, line drawings of hyphae and spores, six black and white plates of fruiting bodies, appendices, and an index of taxa. I particularly appreciated: 1) the extensive comparison of taxa, 2) the greater emphasis on hyphal structure, 3) the attempts to determine relative taxonomic value of the characteristics used, and 4) the systematic inclusion of pistillarin and phenoloxidase data. Breadth and depth are reflected by the many collections examined from 57 herbaria, representing most states and provinces of North America, and 20 other countries beyond the borders of the U.S. and Canada. Moreover, every taxon is represented by a type study, and neotypes are designated when necessary. Dr. Methven's work effectively updates monographs by Corner (1950, 1970) and Kempton & Wells (1968), and his work represents a major advancement in securing taxonomic stability. Graduate science libraries, undergraduate libraries supporting classes in mycology, and anyone interested in coral and cantharelloid fungi should consisder purchasing this book. *C. D. Marr, SUNY-Oneonta, New York, USA.*

Studies on Amanita (Amanitaceae) from Andean Columbia, by R. E. Tulloss, C. L. Ovrebo, and R. E. Halling. Memoirs of The New York Botanical Garden Volume 66. Paper, 46 pp., 17x25.4 cm, 1992. The New York Botanical Garden, Scientific Publications Department, Bronx, NY 10458-5126, USA. ISBN 0-89327-371-6. U.S. Orders $18.60; Non-U.S. Orders $19.90 (All orders prepaid and include postage and handling).

This is a treatise on amanitas occurring in a specific, significant habitat: Columbian oak forests on steep Andean slopes above 1800 meters, which are especially rich in Amanita. According to the publisher's blurb, "This habitat, which is seriously endangered from encroaching pastureland, is interesting phytogeographically because it represents the southern-most distribution of oak (Quercus) in the Americas, and sometimes contains Colombobalanus (Trigonobalanus) excelsa, a genus of Fagaceae that is endemic to Andean Columbia." Ironically, neither the Abstract (which is also provided in Spanish) nor the Introduction, while both concise and businesslike, deliver this compelling rationale. This study increases the number of taxa of Amanita recorded for Columbia from six to thirteen; nine new species are described, plus two new varieties of A. flavoconia. A type study of A. humboldtii is provided and misapplications of European names to Columbian collections by previous authors are critically examined. Line drawings of critical characters are provided and eight of the new taxa are illustrated by black and white photographs. Keys to subgenera and sections of Amanita and to the species from Columbia are provided. Clearly this treatment is an important step towards understanding the mycogeography of Amanita and will be most helpful to monographers and phytogeographers. It is also helpful in highlighting the limits of species concepts based on European collections in interpreting neotropical (and other extra-limital) specimens. *L.M.K.*

Frontiers in Mycology, edited by D. L. Hawksworth. Hardcover, 15x24 cm, 290 pp., 1991. C.A.B. International, Wallingford, Oxon 0X10 8DE, UK (U.S. Agent: 845 North Park Avenue, Tucson, AZ 85719). ISBN 0-85198-698-6. £40.-- US$76.-- (Americas only)

This book consists of edited versions of the key general lectures delivered at the Fourth International Mycological Congress held in Regensburg in 1990. It includes the following: Molecular aspects of ageing... (K. Esser), Fungal growth and development: a molecular

perspective (J.G.H. Wessels), Importance of siderophores in fungal growth, sporulation and spore germination (G. Winkelman), Neoteny in the phylogeny of eumycota (H. Kreisel), Homologies and analogies in the evolution of lichens (J. Poelt), Mycorrhizas in ecosystems... (D. J. Read), The significance of Mycology in medicine (O. Male), Aerobiology and health... (J. Lacey), Lichens and Man (D.H.S. Richardson), Modified amatoxins and phallotoxins for biochemical, biological, and medical research (H. Faulstich), Mycology, mycologists, and biotechnology (J.D. Miller), Mycologists and nature conservation (E. Arnolds), and The teaching of Mycology (J. Webster). Abstracts of each chapter are provided and chapters are illustrated with halftone plates and line drawings, although the deftness of illustration varies among chapters. Though the readability of the chapters also varies, with some authors more creative in their synthesis than others, clearly this volume will provide stimulation to educators and their students in the fields of Mycology and Microbiology. As supplementary readings, many chapters are perfect introductions to applications of Mycology for upper level undergraduate students; the bibliographies are for the most part quite extensive. Although everyone will have their favorites, my students and I have found the chapter by E. Arnolds on nature conservation to be a refreshing and much-needed examination of the relevance of mycology (and how we as Mycologists can contribute) to solving some pressing environmental problems. Educators and their libraries will want to own this volume.
L.M.K.

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NOTICE

A MAJOR CHANGE IN MYCOTAXON EDITORIAL POLICY CONCERNING OFFPRINTS

The cost of offprints has made it difficult or impossible for some of our authors, particularly in developing countries, to obtain these for their use. A new editorial policy addresses this problem:

Beginning with volume 45, a major change is being instituted by MYCOTAXON in regard to offprints. In an effort to be as ecologically sound as possible, the journal will now print only 100 extra copies to serve as offprints for authors. These will be provided *free of charge,* but authors are asked to pay postage and handling charges for shipping these. (If authors cannot obtain the US funds to pay the nominal shipping charges, the journal will ship them without payment, as a courtesy.) One hundred copies will be shipped to the address of the senior author, and *it will no longer be possible to order additional offprints beyond the 100 offprints we provide,* nor to ship to more than one address. For papers with joint authorship, the senior author will be expected to distribute offprints to co–workers on receipt.

Authors of book reviews will receive 25 offprints of their reviews, without charge.

As in the recent past (for articles but not for book reviews), we shall return one set of tear sheets of the article, the original manuscript, and figures to the senior author. *Additional reprints can be made by the author's local printer* from such a manuscript or from the tear sheets. Alternatively, authors who know they will want reprints in addition to the 100 offprints we provide may prefer to receive in addition the original photo-offset negatives used in production of the journal, for use by their local printer. This can be a much more expensive printing procedure. The negatives can be ordered when replying to the letter of acceptance of a manuscript (a shipping and handling fee for preparing the negatives for shipment will be charged).

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NOTICE

THE HOLOMORPH CONFERENCE A CONSIDERATION OF MITOTIC, MEIOTIC & PLEOMORPHIC SPECIATION IN FUNGI

AUGUST 4-7, 1992, NEWPORT, OREGON, U.S.A.

A Symposium, The Holomorph Conference: A Consideration of Mitotic, Meiotic and Pleomorphic Speciation in Fungi, will be held on August 4-7, 1992 in Newport, Oregon. The conference is being organized by Don R. Reynolds, Natural History Museum, Los Angeles, California 90007, and John W. Taylor, University of California, Berkeley, CA 94720 with the support of the National Science Foundation.

Topics to be considered are:

- ✓ *The Asexual Potential for Evolution.*
- ✓ *Integration of Mitotic and Meiotic, Morphological and Molecular Studies on Fungi.*
- ✓ *Nomenclature and Molecules.*
- ✓ *What are the Consequences of Abandoning the Deuteromycetes?*
- ✓ *How Could Mitotic, Meiotic and Pleomorphic Species be Classified Together?*

Reports from the conference are planned for the 1992 meetings of the Mycological Society of America together with the American Phytopathological Society in Portland, Oregon, August 8-12, 1992, which immediately follow the conference; the 2nd International Association for Lichenologists Symposium, Lund, Sweden; and the XIth Congress of European Mycologists, Kew, United Kingdom. Furthermore, CAB International has expressed an interest in publishing the conference proceedings.

For additional information contact:

Don Reynolds ☎ 213 744-3379 FAX 213 746-2999

MYCOTAXON

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NOTICE

6TH INTERNATIONAL CONGRESS OF PLANT PATHOLOGY

JULY 28 - AUGUST 6, 1993

PALAIS DES CONGRÈS DE MONTRÉAL (CANADA)

SCIENTIFIC PROGRAM.

Symposia. The program will consist of five symposia running concurrently each morning. In addition there will be a plenary session on Sustainable Agriculture.

Posters/Discussion Sessions. The discussion sessions will be organized among groups of contributed posters on related topics. Time has been allotted in the afternoons to view the posters, followed by several concurrent discussion sessions, with time remaining to visit the posters for renewed dialogue with the authors.

Satellite Meetings. Persons interested in organizing a satellite meeting are requested to contact the Program Chair: Dr. M. C. Heath, Dept. of Botany, University of Toronto, 25 Willcocks St., Toronto, Ontario, Canada M5S 3B2. FAX: (416) 978-5878.

CONGRESS SECRETARIAT. *Mail all correspondence to:*

Congress Secretariat
6th International Congress of Plant Pathology
National Research Council Canada
Ottawa, Ontario, Canada K1A 0R6

Attention: Doris Ruest (Mrs.)
☎ (613) 993-9228
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REVIEWERS, VOLUME FORTY-FOUR

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